

**HUMAN SKELETAL VARIATION IN THE NEW WORLD DURING
THE HOLOCENE: EFFECTS OF CLIMATE AND SUBSISTENCE
ACROSS GEOGRAPHY AND TIME – PART I**

by

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Abstract

Human morphological variation has been described in previous research as reflecting and responding to environmental factors. Among Europeans and Africans, cranial and postcranial morphologies form clines in their variation across latitude and, by extension, climate. Subsistence practices have also affected variation in some of these morphologies: for example, the adoption of agriculture may have led to decreases in stature. Some of these morphological patterns have been reported in the examination of native humans in the Americas, though much variation in the New World has been unexamined.

This dissertation compares human morphological variation in the Americas with climatic and subsistence factors. A total sample of 3199 pre-contact adult skeletons, representing the majority of the Holocene in North America and some sites from South America, was measured. Up to 143 linear osteometric measurements were taken on crania and postcrania, and used to recreate the proportions and living dimensions of these individuals. These morphologies were compared within and across regions through time. Their variation was then compared with temperature and precipitation modeled using paleoclimatic data, and with subsistence categories based on archaeological evidence.

Results indicated that humans were morphologically varied through the entirety of the Holocene in the Americas. As expected, cranial, nasal, brachial and crural indices, and body breadth corresponded to variation in climatic factors but not with subsistence. Variation in relative torso height and facial index unexpectedly did not relate to environmental factors. Stature variation corresponded to subsistence, and body mass to both climate and subsistence. Analyses indicated that climate and subsistence were

inexorably linked, but that many morphologies did not vary among subsistence practices. Body breadth and crural index varied less in relation to climate than brachial and nasal indices. Furthermore, all samples from the New World were wider-bodied than Old World samples, while having a similar range of variation in intralimb indices. These results indicate different amounts of morphological response to environmental factors, and therefore retained population history in some morphologies, such as body breadth. This history has affected samples from the arctic and the Great Plains, which show extremely different morphological patterns from the rest of the Americas.

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Richard L. Jantz, The University of Tennessee – Knoxville
Marta Mirazón Lahr, Clare College, University of Cambridge

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Acknowledgments in dissertations tend to be interesting (if not slightly narcissistic) affairs. A number of people of consequence to the author—and not necessarily to the research or even to the dissertation—tend to find their names somewhere among these pages. I know from experience that some readers—namely future graduate students and researchers—may peruse these pages in search of the names of contacts and places visited for data collection. So, in an attempt to make things a little easier for those few of you seeking these names and places, feel free to skip ahead to page viii.

This dissertation is a product of over three years' skeletal and osteometric data collection, beginning in 2001 under the support of the Miami University Joanna Jackson Goldman University Prize and continuing in the fall of 2004—after a two-year hiatus—until October of 2006. In several permutations, I have been preoccupied (some might say obsessed) with developing a better understanding of human morphological variation through the study of skeletal remains. However, were it not for others, generous and, in some cases, surpassingly obsessed with aspects of this research, my interests would have waned while I wandered through Europe during my first data collection trip nearly six years ago.

I am indebted to my advisor and chair of my dissertation committee. Chris Ruff has been an intellectual inspiration in my work since I read his 1994 *Yearbook of Physical Anthropology* paper while spending some time under the supervision Marta Lahr at Cambridge in 2000. His meticulous methods and ideas—along with the efforts of Trent Holliday and Ozzie Pearson—lead me to realize how much could be learned from but a few skeletal measurements. Some of the tantalizing questions Chris left open in his papers drove me to spend some weeks in the Duckworth Osteological Collection in the spring of 2000,

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Individual(s)	Institution
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Army Corps of Engineers staff	Burke Museum of Natural History & Culture, Seattle (Army Corps of Engineers)
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Marta Lahr, Jay Stock and Maggie Bellatti	Duckworth Osteological Collection, University of Cambridge (now part of the Leverhulme Centre for Human Evolutionary Studies), Cambridge
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Elise LeCompte and Donna Ruhl	Florida Museum of Natural History, Gainesville
Glen Doran	Florida State University Department of Anthropology, Tallahassee
Lynne Sullivan and Bob Pennington	Frank H. McClung Museum, Knoxville
Michele Morgan	Harvard Peabody Museum of Archaeology and Ethnology, Cambridge
Dawn Cobb	Illinois State Museum, Springfield
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Chapter 1

INTRODUCTION TO THE PROBLEM

“LET US HEAR THE SUSPICIONS. I WILL LOOK AFTER THE PROOFS.”

-Sherlock Holmes, The Adventure of the Three Students

The search for explanations concerning how and why humans are morphologically variable may be regarded as one of the preoccupations of modern biological anthropology. As expressed by numerous authors (e.g., Ruff, 1994a; Holliday, 1995; Pearson, 1997; Weinstein, 2001), there has been a growing interest in the last few decades in discerning the influence that environment—namely, climate, subsistence and activity—has on variation in human morphology. Roberts (1978) and Ruff (1994a) pointed out that descriptive (and often biased) observations about the cause-and-effect relationship of environment and morphology have been made by authors for millennia, and it has not been until recently that researchers have implemented hypothesis-driven, objective analyses of the relationships between environmental factors and human morphology.

A tenet of all of this research has been that morphological variation, as observed in the skeleton, is a product of genetics and environment. More to the point, human variation in body size, shape and proportions relates to ecological and mechanical models, which propose that these morphologies respond to the influence of thermoregulation (i.e., ecogeographic “rules”), nutrition, stress, and activity (e.g., mobility, food procurement and processing, etc.). That variation in physical properties of the skeleton consistently has been shown to correspond to ancestry, geography, subsistence, and climate, among many genetic and environmental factors, has supported the contention that the skeleton is plastic (*in vivo*) or

adaptive (over generations), and motivates further studies to discern the differential effects of these factors on the morphology of the body.

A recent surge in the study of human morphological variation has been motivated by observations of physical diversity among late Pleistocene/early Holocene humans, and, by extension, the potentially extreme morphology of the Neandertals. Much of the earliest investigation focused on variation observed in the cranium. Not until the publication of papers by Trinkaus (1981), Jacobs (1985), and Ruff (1991) did *postcranial* skeletal diversity in relation to climate attain specific attention. Prior to these papers, as will be reviewed in Chapter 3, researchers of the postcranium had focused on the effects of nutrition and stress on the skeleton, as well as physiology and some anthropometric variation in relation to climate. The latter studies had a tendency to use very small sample sizes, be typological or descriptive, and, with a few exceptions, to rely more on deductive than inductive reasoning.¹

The majority of the research on human skeletal variation (especially of the postcrania) has concerned populations of the Old World—Europe, Asia and Africa. The reasoning behind this is logical. As a main concern among researchers has been the exploration of diversity among fossil hominins, which have been found in Europe, Asia and Africa, and on human origins, researchers have chosen to compare them with recent humans from the same locations. From their studies, a consensus conclusion is that body proportions and shape do vary, among many factors, relative to geography (and, ostensibly, climate) and that these

¹ This is an important distinction to make, subtle though it may seem. In deductive reasoning, a general concept is examined by looking at specifics, whereas in inductive reasoning, specific observations are combined to yield a general concept. In the case of earlier studies, researchers began with the concept that morphological variation is governed, in part, by ecogeographic rules; they then examined various examples of human morphologies and stated that the rules did or did not apply. A criticism of this methodology is explored further in Chapter 3, but it must be stated at this point that this study uses general concepts to develop hypotheses, but favors inductive reasoning in its analyses to test them. The quotes from Sherlock Holmes that are found at the start of each chapter are included with a touch of irony; Holmesian Deduction will not help clarify the relationships under consideration, as we can never know all of the factors influencing morphological diversity.

may extend far back into time for hominins (Ruff, 2002a). If samples from the Americas are included in these studies, they are commonly taken from the extreme high latitudes (i.e., the Inuit), often as examples of “extreme” cold-adapted morphologies. Only a few other New World human populations have been included in examinations of postcranial skeletal variation.

Notably, little is known about the morphological diversity of humans in the Americas, especially prior to the arrival of Europeans (which had a profound effect on demographics through population decimation, interbreeding and migration), or how morphological diversity relates to environmental factors. It has not been in question for some time that humans native to the New World were and are varied, mostly based on the work of Boas (1929), Laughlin (1951) and others. Marshall Newman (1953, 1960), in examining anthropometric variation collected from various sources, demonstrated that clines in body mass are evident in the Americas, and that even within general geographic regions (e.g., the Alaskan Arctic), there is notable variation. With the exception of data gathered by Boas as part of the 1892 Columbian World’s Fair and examined in recent years by Jantz and others (e.g., Jantz et al., 1992), Newman’s early work remains one of the most extensive surveys of New World postcranial morphological diversity. No broad survey of morphological diversity in the postcrania of New World skeletal remains has been conducted, and only two researchers—Howells (1973, 1989) and Lahr (1995)—have examined cranial variation across a geographic range of American skulls. In the half-century since Newman’s research, the diversity of New World morphology relative to global variation, as well as its relationship with climate, activity and subsistence, continues to be debated among researchers.

Indeed, researchers of ecogeographic patterning of Old World morphological variation point out that diversity in the Americas, while extensive, is not as great as, and fails to demonstrate the stark clines evident in, Europe, Asia and Africa. This conclusion is based on only a few studies, most of which have relied on aggregated anthropometric data culled from published and unpublished sources. For instance, as Holliday stated in his dissertation (1995):

Body proportion differences appear to be the result of long-term climatic selection. Evolution in body proportions takes a long time, as evidenced by the relative lack of ecogeographical patterning in human body shape in the New World relative to the Old World. The *lack of variance* in body shape is not due to less climatic variability in the Americas, but to the fact that the New World has been inhabited for only about 15,000 years.... (p. 4, emphasis added)

Holliday is not alone in this contention. Ruff, in his 1994 summary of climatic adaptation in hominids, also emphasizes that, while variation in relation to environmental conditions (openness, temperature, precipitation, and altitude) is evident in the morphological diversity of the Americas, it is not as evident as in the Old World and may be restricted by differences in morphological plasticity:

Among a very limited sampling of bi-iliac breadth data for the New World derived from Eveleth and Tanner (1976) and Johnston and Schell (1979), I can find only general correspondence between body (bi-iliac) breadth and latitude.... It may be that native New World populations have not been in their present environments long enough to have developed the same depth of clines in body breadth as Old World

populations. Thus, the expected effect of the long-term “cold filtering,”² or selection for cold-adapted morphology of the initial migrants from northeast Asia—a large body breadth—is still present to some degree throughout the New World (Ruff, 1994a, p. 79).

Ruff proceeded to point out that cultural buffering may also have been advanced enough to remove selective pressures on morphology in New World populations. Significantly, he also noted at the end of the same paragraph that “[m]ore data for additional Native American populations are obviously necessary to further evaluate” the various relationships of morphological diversity in the Americas to environmental influences.

Moreover, researchers who have focused more generally on morphological variation in the Americas have suggested muted relationships with climate, and potentially more influential effects from other factors. Jantz (2006), for example, following an extensive analysis of limb lengths, stature, relative sitting height, and body breadths from the Boas anthropometric data, noted that:

The evidence presented...provides only limited support for Native American size and shape variation conforming to Bergmann-Allen [i.e., ecogeographic] predictions. That July temperature is much more highly correlated with body measurements than January temperature may mean that heat stress is more important than cold stress, a pattern found in Europe (Crognier 1981).... The strong relationship between body dimensions and longitude indicates that factors other than climate are as important, if

² The concept of a “cold filter” creating a selection factor for wider-bodied and more massive humans as they passed from Beringia to the Americas—one hypothesized migration route—and that this body shape was retained by all native human groups in the Americas through the Holocene, was originally proposed by T.D. Stewart in his book *The People of America* (1973). Stewart, however, advocated an American homotype, in which variation was limited and could be considered homogeneous relative to global physical diversity (as he clearly states on page 55 of that book).

not more so, than climate in determining spatial patterning. One of these factors is likely to be extensive movement of populations among climate zones (p. 784).

His principal conclusion was that human variation in the New World reflects population history more than climate adaptation. Importantly, he emphasized that cormic indices (relative lower limb length-to-trunk height) among the native groups had a range equal to that found among humans in the Old World, and so indicate a great amount of variation among New World humans. In fact, Jantz clearly stated at the conclusion of his 2006 *Handbook of North American Indians, Volume 3* chapter that “[t]he Americas are the most diverse regions in the world, genetically and anthropometrically (p. 788).” This is an emerging perspective on human diversity in the New World, supported by a growing number of authors, though Africa remains the most genetically diverse continent (e.g., Lahr, 1995; Ross et al., 2002; Owsley and Jantz, 2005; Powell, 2005; Kemp et al., 2007).

If the morphological variation is this extensive in the Americas, however, then it must relate both to ancestry and environment. Parsimoniously, it makes little sense to attribute it all to ancestry (e.g., constant migration from Asia, Oceania and/or Europe to the Americas), and there is no evidence to support such (as is reviewed in the following chapter). Though different ancestry undoubtedly contributes to some of the diversity, much of the resulting morphological variation in the Americas must have developed *in situ*, arising from genetic drift, selection, and founder effects, in addition to variation as a result of developmental plasticity. These are not mutually exclusive; variation in stature, for example, is attributable to potential growth allowed genetically that is suppressed or augmented by nutrition and environmental stress (e.g., arising from disease or climate).

Jantz's analysis of recent populations argues that variation occurs, to a large extent, independently from the effects of climate (Jantz, 2006). It is suggested by him, as well as by Ruff (1994a), that humans may have been technologically buffering themselves against climatic influences on morphology by the time colonization of the Americas occurred. Yet, other authors, also examining anthropometrics, have documented some patterns of morphological variation in the New World that match clinal expectations in relation to climate factors (e.g., Roberts, 1978; Johnston and Schell, 1979; Stinson, 1990). Are these conflicting results due to sampling (sample sizes and geographic distribution), an effect of examining native populations at their demographic nadir (i.e., after contact; Ubelaker, 1992, 2006a), the morphologies being compared, interobserver error, or other factors? A major limitation to all of these studies is their reliance on analyzing pre-existing data, and the use of a limited number of postcranial dimensions that only allows for assessment of a limited number of morphological characters—stature, body mass, relative and absolute sitting height, lower limb length, and relative and absolute body breadth. It is also possible that other environmental factors, such as nutrition, affect some of these dimensions, therefore confounding the apparent effects.

It is clear, from this brief summary alone, that a detailed investigation of more morphological characters, across greater temporal depth and geographic breadth would benefit the documentation and understanding of patterns in New World human variation. Morphologies that have been described as covarying with climate in the Old World, namely intralimb indices, cannot be examined using these pre-existing anthropometric data, and others, such as bi-iliac breadth, have only been collected in a few samples. We are limited by how much we can know using only anthropometric data, despite the extensiveness and large

sample sizes available. Additionally, while crania have been studied more extensively, much of this has been performed to investigate affinities among samples with respect to American population origins. Seldom have studies looked at clinal cranial variation. In addition, the relationship of cranial to postcranial variation has not been examined extensively (Auerbach, 2007).

This dissertation sets out to examine morphological diversity among a sampling of New World populations, from the most ancient skeletons to those dating to the time of European contact³. Morphological variation is analyzed for both crania and postcrania, and with respect to two general areas of potential environmental influence: climate (and geography) and subsistence (as a proxy for nutrition, stress, and activity). The central goal is to address three areas of inquiry:

- 1) How much do cranial and postcranial morphology vary across the Americas? Does this variation among morphologies covary or is it independent?
- 2) Does morphological variation occur in discernable patterns? How do these morphologies relate to environmental factors (i.e., climate and subsistence)?
- 3) How does this variation compare with what has been documented in the Old World (specifically, Africa and Europe)?

An understanding of the basic answers to these questions is important for a number of purposes. The Americas have been perceived as a “natural experiment” in examining the relationship of human variation to environmental factors, assuming a generally common

³ The timing of contact with the Europeans is variable throughout the Americas. Arguably, groups living in Greenland and Newfoundland had the earliest documented encounters with the Vikings, but not until the concentrated colonization of the Americas by Western Europeans did external influences from the Old World likely cause major depopulation and migration. This noted, however, potential repeated colonization events and continuous contact across the Bering Strait among Inuit cultures kept the New World from complete isolation.

origin from a group of populations living in Asia (more discussion on this follows in Chapter 2). Hypothetically, if humans that migrated were from a single population with a specific morphology, then all morphological traits observed in the Americas would be resulting from selection and drift occurring in the New World. Even though this is an overly simplistic model—multiple migrations or founding groups most definitely contributed to the final “indigenous” makeup of the Americas, occurring from a potential variety of source populations and over the length of the occupation of the New World—the concept that morphological variation in the Americas developed *in situ* is still a testable concept. This assumes that morphological changes occur quickly enough to be evident in the brief time that humans have lived in the New World relative to the Old World, which, again, can also be assessed by this study.

The latter issue is of interest not only for studies of variation and adaptation in the Americas, but in studies of human variation in general and a refinement of the model of morphological adaptation to environmental factors. It is also useful in addressing the time depth necessary for the anatomical changes in relation to climate observed in the Old World, as “anatomically modern humans” colonized glacial Europe from Africa. Current evidence in Europe has indicated that 10,000 years elapsed between the first anatomically modern human expansion into Europe and the development of a more “cold adapted” morphology, with wider bodies and shorter limbs (especially distal limbs) (Holliday, 1995).

The three questions posed above are investigated across both geography and time. Most of the analysis conducted focuses on samples from North America, though some samples from Mesoamerica (though geographically part of North America, it is considered separately here) and South America are included to extend the examination geographically. As noted

by Jantz (2006), North America is thought to be less variable morphologically and genetically than South America, so generally limiting this study to samples from North America is considered methodologically conservative. This is also restricted for practical purposes; gaining access to South American samples is generally more difficult, most skeletal collections of any size are currently limited to the Pacific margin (with the exception of northern Argentina and southeastern Brazil), and the populations they represent are undoubtedly affected by the as-yet unresolved interactions and influences from the multitude of complex societies that existed across the Andes and into the Amazon⁴.

In summation, this dissertation seeks to document human morphological variation in the Americas—specifically North America—through time and across geography, in relation to environmental factors. The following two chapters provide a summary of the existing literature on this topic. First, an overview of population history in the Americas is developed, including a brief discussion of the competing hypotheses for New World human origins. The second background chapter focuses on a review of current theory on the relationship of human morphological variation in relation to climate and subsistence, and documented patterns of variation in the Old World and the Americas. Following the literature review, specific hypotheses addressed in this dissertation are explicated in section 3.4 of Chapter 3.

⁴ We may not even yet know of some of these societies. As described by Denevan (2001) and Erickson (2000), earthworks are possibly evident in the western Amazon Basin, created by a culture that, archaeologically, has yet to be documented (or has been documented, but researchers haven't drawn the connection).

Chapter 2

ACROSS LONGITUDE & LATITUDE: HUMANS IN THE AMERICAS (BACKGROUND I)

“CIRCUMSTANTIAL EVIDENCE IS A VERY TRICKY THING. IT MAY SEEM TO POINT VERY STRAIGHT TO ONE THING, BUT IF YOU CHANGE YOUR OWN POINT OF VIEW A LITTLE, YOU MAY FIND IT POINTING IN AN EQUALLY UNCOMPROMISING MANNER TO SOMETHING ENTIRELY DIFFERENT.”

-Sherlock Holmes, The Bascombe Valley Mystery

Archaeological, biological, and linguistic data have been used in reconstructing the origins and movements of humans in the Americas since the nineteenth century. Although the data are abundant, and continue to increase, they are also effectively circumstantial. The subject is highly controversial, especially concerning the earliest occupants of the Americas (e.g., Dillehay, 2000; Bonnichsen et al., 2005; Mann, 2005; Buikstra, 2006; Stanford, 2006). The compatibility of different lines of evidence has been called into serious question, namely between linguistic and biological data (Meltzer, 1993; Goddard and Campbell, 1994; Campbell, 1997), between biological and archaeological data, and even biological data with each other (i.e., genetic vs. dental vs. craniometric) (Bateman et al., 1990; Nichols, 1990; Bonnichsen, 1999; Powell, 2005). Continuing efforts initiated within the last decade, however, have sought to bring these various perspectives into direct conversation with each other to synthesize more holistic models of New World human origins and migrations.

Understanding these models is essential for the interpretations of human morphological variation in the Americas. Although the specific morphology of ancestral populations and the earliest occupants of the Americas is not known, interpretation of morphological variation in the earliest observable samples and changes in variation through time are in part dependent on whether the initial populations were themselves morphologically variable; it is possible that this may be inferred through the number of migrations and the number of source

locations from which these groups migrated¹. In accordance with this information is a desire to understand when people migrated, to determine how much time potentially elapsed between the oldest skeletal samples and the original migrants, and therefore how much time available to generate observed morphological variation. Knowing, generally, where groups settled, moved, and how they related to each other is furthermore important in discerning the environments encountered by populations, which in turn would have affected thermoregulation and subsistence practices, among many other adaptations.

For example, if there is evidence for American ancestral groups to have originated from sites with long habitation histories in the cold regions of far northeastern Siberia, this would yield the expectation that the earliest skeletal samples observed have arctic morphologies. Should the earliest skeletons not demonstrate this morphological suite of characters (see the next chapter), then the archaeological estimates of the length of the occupation in Siberia are flawed, the human ancestors from Siberia did not develop the cold-adapted morphologies (either from cultural buffering or a lack of selective pressures despite long occupation), the descendants in the Americas rapidly changed in response to new environments (or bottlenecks and founder effects), or the populations living in those sites from Siberia were not ancestral to the skeletons found in the Americas. The data concerning the earliest inhabitants of Siberia and the New World are still emerging, so these hypotheses cannot be directly addressed yet. In addition, new information about population movements and relationships throughout the Holocene (e.g., Storey et al., 2007) are continuously published

¹ This is unquestionably an oversimplification, however, as a “polytypic” group could have migrated together, a series of related populations could have migrated in multiple groups over time, or many of the groups that did migrate vanished archaeologically, only to leave some genetic (and possibly phenotypic) influence on descendent skeletal groups. In addition, the “source” populations have undergone changes in morphology as well, and so directly comparing their modern descendants with indigenous New World humans could misinform conclusions.

from a number of academic disciplines, and it is this archaeological, genetic, and linguistic evidence that allows for the testing of these various hypotheses concerning the origins and movements of people in the New World.

This chapter will endeavor to summarize the salient information from the archaeological, genetic, linguistic, and skeletal literature in order to provide a general picture of current thought concerning pre-Columbian New World human movement and relationships. Of course, this is a tremendous task; the literature spans decades of monographs, peer-reviewed papers, semi-popular volumes, edited papers, and meeting presentations, all of which concern a discipline that dates back, by most accounts, to the first excavations carried out by Thomas Jefferson in the late eighteenth century (Willey and Sabloff, 1993)². For this reason, this chapter will not attempt to provide a detailed historical account of these topics; rather, it concentrates on developments of the last twenty years in regard to the origins and migrations of humans into the Americas, followed by general perspectives on the cultural traditions and movements of peoples in more recent millennia, focusing attention on the North American regions examined in this dissertation. More thorough, current discussions on models of human migration to and within the New World may be found in an ever-growing literature, including books by Dixon (1999), Dillehay (2000), Bonnichsen and Turnmire (2004), Fagan (2005); Bonnichsen et al. (2005), Powell (2005), Morrow and Gnecco (2006), and Walker and Driskell (2007), as well as papers published in the recent *Handbook of North American Indians, Volume 3: Environment, Origins and Population* (Ubelaker, 2006b). One point made in many of these works, but beyond the scope of this chapter's discussion, is the nature of migrations: they could have been single, temporally short events; continuous, long

² Although this is a popular example of the first methodical archeological excavation in North America, organized, contextual excavations did not begin until the late nineteenth century (at the earliest), and careful excavations of complete human remains were not carried out until much later (Buikstra, 2006).

colonization events by a single or multiple groups; or any other number of combinations of temporal periods and source populations. Archaeology cannot resolve the form that migrations took yet, and so the term is used with some ambiguity in the following discussion.

2.1: A matter of circumstance: ideas about origins and arrivals

Much recent effort has been made by archeologists, skeletal biologists, and geneticists on revising previously held ideas about the antiquity, origins, and migration routes of the first humans to colonize the Americas. Attention to these topics has been ongoing within anthropology for at least a century (e.g., Fewkes et al., 1912)³, and with that interest a constant procession of new sites and evidence. The prevailing model for human origins in the New World was developed by the mid-1950s (Willey, 1960), based on a number of earlier discoveries (most between 1900 and 1950), and remained generally unchanged for at least half a century: humans arrived via the Beringian land bridge from northeast Asia, in pursuit of large land mammals that migrated when an open land route emerged at the end of the late Pleistocene (the Late Wisconsin), bringing with them Clovis or Clovis-like lithic technology (Stewart, 1973). This concept was grounded on a geographically broad distribution of sites characterized by the presence of bifacial, fluted points (i.e., the Clovis industry and South American fishtail points), occasionally associated with large mammals (Haynes, 1980; Collins, 1999; Fiedel, 2000). Over the fifty years following the discovery of these points in conjunction with mammoth remains near Clovis, New Mexico (Cotter, 1937),

³ The symposium referenced here, entitled “The Problems of the Unity or Plurality and the Probable Place of Origin of the American Aborigines,” is a curiosity. It may be the first time that specialists in all disciplines of anthropology met with the single purpose of discussing the origins and variation of humans in the New World. Much of the thinking that dominated these disciplines for the following seventy-five years—thinking that is discussed briefly above and in section 2.5—is clearly stated by participants who contributed to these published proceedings. Worth noting are the presence of two voices among this group that held the strongest sway over archaeological interpretations at the time and for decades after—Aleš Hrdlička and William Holmes (Powell, 2005). (Note that, on page 36 of the proceedings, some dissenting opinion between these two is demonstrated.)

archaeologists uncovered sites in North and South America that were used to support or question the developing perspective, now termed the “Clovis-first” hypothesis. Sites claiming greater antiquity than Clovis (and therefore challenging the dominant Clovis-first paradigm) or other lithic industries (e.g., Folsom or South American fishtail technologies) were often subjected to dissenting views and were openly questioned themselves (e.g., Lynch, 1990; Dillehay, 2000). Often, though, the rejection of sites was justified due to questionable archaeological methodologies (Fiedel, 2000)⁴. Along with (or perhaps fundamental to) this prevailing opinion of big-game hunting and a colonization horizon of ca. 12,000 yBP was the idea that humans in the Americas were effectively a culturally and biologically homogeneous population.

It was not until a series of discoveries and subsequent papers, beginning in the 1980s, that the debate became invigorated by new perspectives that began to overturn and diversify the dominant paradigm (Meltzer, 2006). Of special note in this regard are the publications by Fladmark (1979); Greenberg et al. (1986), Gruhn (1988), Dillehay and Meltzer (1991), Easton (1992), Torroni et al. (1992 and 1994), Bonnicksen and Steele (1994), Merriwether et al. (1994), Lahr (1995), Dillehay (1997), Collins (1999), and Fiedel (1999). Other papers dating to this time period are also relevant in the creation of new models, but these represent the development of critical new research paradigms and data sources, as well as inspiration

⁴ A comment on this suppression of findings: Powell (2005) enumerated the problems that have waylaid New World origins archaeology, citing a “lack of agreement...due in part to competing schools of thought, parochialism, and reliance on inadequate data” (p. 23). As individuals who oppose the homogeneity of human variation in the Americas and the Clovis-first model have gathered more evidentiary and peer support for their models, they have taken to severely criticizing Hrdlicka, among many (such as Haynes, Holmes, Lynch, and Stewart) (see examples in Dillehay, 2000; Fagan, 2005; Mann, 2005; Powell, 2005). Although these aspersions are, perhaps, defensible—Hrdlička was notorious for unwarrantedly rejecting evidence if it did not support his paradigm—they are unnecessary and misleading; many of these past scientists were limited by the methods available and the theoretical perspectives prevalent at the time. This does not make their inferences any less incorrect, or undo the detrimental effect these had in retarding research in the discipline, but it should temper the current trend to condemn their actions wholly. Yet, current researchers can learn from the example of this past scientific censorship, so that they may avoid repeating the same mistakes as new perspectives are developed.

for continued debate and research in these topics. Although the arguments made by some of these studies have themselves been called into serious question by further investigation, they remain important influences in rekindling the debate over origins and the earliest movements of humans in the Americas. What follows is a review of current ideas, placed into some historical context, about which humans colonized the Americas, their diversity, how and when they arrived in the New World, and where they dispersed upon reaching a continent previously uninhabited by humans.

Origins (Who? When? From where?):

With few exceptions (e.g., Hicks, 1998; Bradley and Stanford, 2004⁵), researchers of American antiquity have agreed that the ancestors of all New World indigenous populations originated wholly in eastern Asia (e.g., Sauer, 1944; Willey, 1966; Stewart, 1973; Torroni et al., 1993a; Bonnicksen and Steele, 1994; Merriwether et al., 1995; Fiedel, 2000; Straus, 2000; Elias, 2002). Agreement, however, generally stops after this single point. Debates continue over the specific location (or locations) from which the first migrants emerged, when they migrated, and how they traveled to the Americas. This subsection reviews the first two of these issues; migration routes are considered separately in the next subsection.

Until the last twenty years, research linking New World populations to those of the Old World was almost exclusively reliant on archaeological evidence. This evidence consists predominantly of projectile points (in addition to blades choppers, and burins), as well as bones bearing butchering marks, rather than other artifacts and perishable evidence (Dillehay and Rossen, 2002). Archaeologists have focused on identifying Old World lithic antecedents

⁵ A clarification: Bradley and Stanford argue that, among the earliest inhabitants were Solutrean toolmakers who may or may not have contributed to the modern indigenous gene pool. They do not argue that the majority of New World humans are of European descent (personal communication from Stanford, 2006). Note, though, that this argument has changed since its inception (Straus et al., 2005).

for Clovis bifacial points (e.g., Haynes, 1980; West, 1996; Fiedel, 2006). Under this logic, chronologically associating widespread lithic industries from the Americas to similar technologies in the Old World would resolve two of the major questions concerning the origins of humans in the Americas: where did they come from, and when? Archaeological evidence was aided by the use of blood group and serum polymorphisms (O'Rourke et al., 1985; O'Rourke, 2006) and typological comparisons of crania (e.g., Neumann, 1952), but the focus on lithics remained dominant, driven by the lack of ancient skeletal remains, the ubiquity of well-preserved stone tools (and the relative ease of their identification), and a lack of alternative methods for investigating human diversity (e.g., mitochondrial DNA).

Looking for cultural relationships and temporal sequences among lithics, however, proved to be extremely challenging. The prime problem facing archaeologists twenty years ago was a continuing lack of parallel lithic industries in Western Beringia, Eastern Beringia, the central regions of North America, and South America, that demonstrated 1) a temporal sequence that might suggest antecedent-descendent technologies, or 2) a clear relationship between modes of manufacture or usage (Powers and Hoffecker, 1989; Meltzer, 2002). Even with multiple late Pleistocene sites in all four locations presenting variants of Clovis technology (Collins, 1999) and potentially numerous other lithic tools (Bryan and Gruhn, 2003), the relationships among the lithic tool industries was (and continues to be) plagued by the second problem stated above. Lithic artifacts from individual sites were cited as potential precursors to Clovis technology (e.g., the Ushki Lake I site in Kamchatka and the Old Crow site in Alaska), but by the mid-1980s, many of the radiocarbon dates of these sites had been revised to coinciding with or after the earliest Clovis sites in (subarctic) North America (Lozhkin and Parii, 1985, as reported by Hoffecker et al., 1993; Nelson et al., 1986). Many

remaining sites in Siberia preceded the appearance of Clovis in the New World, but represented tool industries so distinct that few archaeologists were willing to cite them as antecedent technologies to the late Pleistocene technologies of central North America (Dixon, 2006). The argument did emerge among some archaeologists, however, that a rapid colonization by initial migrants led to multiple, archaeologically invisible changes in lithic technologies as groups quickly moved through various ecological zones (e.g., West, 1983), but this was a hypothesis that could not be tested.

Current archaeology still has not uncovered clear evidence for the precise antecedents of the earliest tool industries in the majority of the Americas. If the Clovis tradition has a primacy among the stone tool industries of North America south of Beringia (and led to the development of the varied fishtail points found in South America) and represents the initial migration of humans in the New World, then it would require antecedent technologies in Asia (Fiedel, 2000; Goebel, 2004), none of which have convincingly been associated (West, 1996; Meltzer, 2002; Goebel and Slobodin, 2005, but see Powers, 1990; Yesner, 1996; Straus et al., 2005). However, similarities in basic industries on the Siberian and Alaskan (Western and Eastern) sides of Beringia, especially in microblade technologies, have been convincingly asserted for Allerød-Bølling cycle warming colonization events in the far northwestern interior of North America (Hoffecker et al., 1993; Goebel et al., 2003; Bever, 2006). Archaeological evidence argues that humans, either related to or trading with northeastern Siberian groups, occupied central southern Alaska by 12,400 yBP (Largent, 2004, cf. Hamilton and Goebel, 2005). Relating these groups with those indicated further south cannot be resolved by the current evidence; there are no recognized archaeological sites that chronologically connect the earliest Alaskan sites (e.g., Swan Point) to the first

Clovis sites in North America (Mandryk et al., 2001; Dixon, 2006), and most only predate the first Clovis sites by a few centuries⁶ (or, though often not reported, within the same ranges of age estimation error) (Madsen, 2004a).

A number of criticisms have been levied against the modern archaeological methodology used in search of the origins for populations that migrated to the Americas, and cite this errant approach as the reason why New World precursors in Asia have not been recognized, or why the earliest occupations of the Americas are overlooked. A common critique is that the “Clovis-first” model has not been under critical assessment until quite recently. The onus of proof has been on alternative hypotheses to support or fail to support this model (Irving, 1985; Bonnicksen and Schneider, 2004; Fedje et al., 2004; cf. Griffin, 1977). Coupled with this is the criticism that the approach emphasizing the differences among lithic technologies—almost exclusively points—artificially elevates their importance, possibly inflates their differences, and reduces potentially meaningful cultural and ecological data to typology (Wendorf and Hester, 1962; Dillehay and Meltzer, 1991). Although the similarity of lithic points is important in creating cultural complexes and designating possible relationships among human groups, they must be considered in the context of environmental variation, function, and manufacture (Sellet, 2001; Stanford et al., 2005). Furthermore, following this line of argument, the focus on identifying lithic technologies in Western Beringia that closely resemble those found in central North America—be it Clovis blades, spear points, other macroblades (Collins and Lohse, 2004) or other, earlier lithics—is erroneous. Lithic technologies are adapted to the environment in which they are employed.

⁶ With the recent publication of Waters and Stafford’s (2007) re-dating of Clovis sites, however, this discrepancy might not be as severe as has been currently thought; Clovis could be a younger and shorter-lived tool industry in the Americas. If their dates are accurate, this further questions the primacy of Clovis—some Mammoth butcher sites predate the new Clovis dates by more than 1000 years (Joyce, 2006). Note that, like Greenberg et al. (1986), this paper was published with immediate criticism (Meltzer, as quoted by Mann, 2007).

The record in the Americas is too discontinuous to allow for lithic “phylogenies” to be devised, and, most importantly, lithic industries unquestionably *point to* group relatedness (via trade networks, gene exchange, or complete kinship), but do not *equal* genetic association (Madsen, 2004b; Meltzer, 2004; Byers and Ugan, 2005; Driskell and Walker, 2006). That is, lithic industries and the variation of the people who made them are not related isomorphically (Sellet, 2001), but a relationship *does* exist (though sometimes this may be cryptic, due to missing archaeological evidence arising from an incomplete record or rapid technological changes).

As emphasized by Sellet (2001, p. 61), “cultural diversity cannot be measured through typologies of projectile points.” This argument is valid for the overestimation or underestimation of cultural diversity—and, vis-à-vis, genetic diversity. This is because multiple lithic point styles could be generated by a group of related individuals to serve several functions, while single lithic “types” may be copied by neighboring groups or otherwise co-opted into their toolkits, and even convergently produced under similar ecological demands (Clarke, 1978). In other words, even with widespread discoveries of a given lithic technology, it still is indeterminate whether those stone tools were culturally exchanged across pre-existing networks (traded or copied), or if they were carried by a single, highly-mobile cultural group (Whitley and Dorn, 1993; but see Storck, 1991; Straus, 2000; Fiedel, 2005). Additionally, as pointed out by Collins (1999; 2002), only recently has attention been focused on intra-site variation in lithic artifacts, or the identification of regional variants of all components of a perceived tool industry.

Perhaps the most salient critique, emphasized by Kelly (2003) and Dillehay (1999, 2000), is that in the archaeological “zeal” for and practical dependence on lithic blades and similar

evidence, tools created from perishable materials or simple lithics—if they are present—could be overlooked. These technologies may have carried great significance relative to the subsistence and survival of the earliest human inhabitants of the Americas. Ensuring such objects are anthropogenic in origin, however, requires extremely methodical excavation (e.g., Dillehay, 1997). Yet, these and other authors bring up a crucial point: in searching for the archaeological evidence of the first people in the Americas, how will we know what to look for? What of their technologies might be expected to survive? For example, based on lithic and small habitation site discoveries, humans were present in western Siberia by 18,000 yBP along the Lena River (Goebel and Slobodin, 2005), and not long after settled in central Siberia with some permanency (Bettinger and Young, 2004). If we seek other, less “visible” signs of human habitation, might older sites be uncovered that bridge the apparent temporal and technological gap between Siberia and the Americas? At present, it is clear that, while archaeology has been able to indicate generally from where some lithic technologies in the Americas came (namely, those in late Pleistocene Beringia), it cannot and may never be able to indicate *precisely* from where the technologies, and therefore the people, emerged (Fedje, 2004).

The conundrum of *when* people populated the Americas is resolved to some degree when pre-Clovis sites are taken into consideration. That humans occupied South America at roughly the same time as the earliest verified strata in Swan Point, Alaska, is not in debate: the Monte Verde site in central southern Chile—though still questioned by some—has been verified to be at least 12,500 years old (Adovasio and Pedler, 1997; Meltzer et al., 1997; Fiedel, 2000; Kelly, 2003). Whether other sites in South America (Dillehay, 1999; Fiedel, 2000; Gruhn, 2005) or central North America (Adovasio et al., 1990; Johnson, 1997;

Adovasio and Pedler, 2005; Goodyear, 2005) are accepted to be of similar antiquity, the archaeological dispute is moot; humans, most likely from Asia, migrated to the Americas at least by the end of the Last Glacial Maximum (ca. 14,000 yBP), and colonized central southern Chile (and, logically, probably multiple other sites in between). Granted, Monte Verde is a single data point, and it is difficult at present to argue either way whether these humans relate to groups who lived in North America 1000 years later. Yet, having one pre-Clovis site, located geographically so far from the next-oldest undisputed sites in North America (located in Alaska), and most likely others (Meadowcroft, Cactus Hill, and Topper) (Goodyear, 2005; but see Grayson, 2004), changes the dominant paradigm for the peopling of the Americas. In accepting the existence of pre-Clovis populations in the Americas, the issue of directly linking Clovis to Asian precursors may also be immaterial. Though the tool industry certainly has elements linking it to Asian lithic technologies (Straus, 2000; Collins and Lohse, 2004), Clovis manufacture (and certainly usage) is likely unique in North America (Meltzer, 2004), just as fishtail points may be unique developments in South America (Bryan and Gruhn, 2003). Two developing paradigms emerge from the recent literature concerning the presence of humans before Clovis:

- Humans were present in the Americas before the development of Clovis lithic technology. Therefore, if Clovis does not represent the initial populating of the Americas, the burden of “proof” for finding its progenitor corollary in the Old World is removed (Fiedel, 1999; Madsen, 2004a, cf. Haynes, 2005).
- The first humans to colonize the New World developed a variety of tools and methods for living in the diverse and ever-changing environments they encountered (Kelly and Todd, 1988; Reitz, 2001; Roosevelt et al., 2002; Dellehay and Rossen,

2002; Gnecco, 2003; Byers and Ugan, 2005; Driskell and Walker, 2006; Randall and Hollenbach, 2006). Even if Clovis were a major influence on human ecology across all of the Americas after its development (as implied by its ubiquity), the fact that it had regional variants (Bonnichsen, 1991; Collins, 1999; Collins and Lohse, 2004) and may have been short-lived (Waters and Stafford, 2007), makes a case for extensive variation in environment-human interactions in the lifeway(s) that Clovis represents.

Is it likely that humans migrated long before the end of the Last Glacial Maximum (LGM)? Based on geological evidence, there were brief (ca. 500-1500 year) warming periods during the LGM that would have permitted movement—most likely along the coast—to the New World from southeastern Siberia (Sarnthein et al., 2006). Humans lived at the edge of Siberia prior to 20,000 years ago (perhaps much longer before), and so had the technological aptitude to survive in what have been modeled as marginal environments (Bonnichsen and Schneider, 2004). Whether these people moved into Beringia and further south, despite many new papers seeking earlier evidence (e.g., D.B. Maden's *Entering America* volume), has yet to be accepted to have occurred before the end of the LGM based on archaeological evidence. Excavated artifacts and signs of human habitation are ambiguous and too preliminary to argue for anything more than the possibility that humans migrated to the Americas before the LGM (Grayson, 2004).

It is of little surprise, then, that Greenberg and colleagues (1986) sought another approach that largely circumvented the archaeological evidence, using a broad perspective conceptual argument based on comparing language, dental, and genetic data (RFLPs, immunoglobulin groups based on the *Gm* locus, and blood serum data). Their tripartite model—that most groups in the Americas are a single genetic “stock” representing a single migration (the

“Amerinds”), followed by two later migrations that gave rise to the Pacific Northwest (and later U.S. Southwest) Na-Dené / Athapascan speakers and to the arctic Inuit— immediately came under vigorous debate (see the comments following the original paper by Campbell, Laughlin, Szlathmary, and Weiss & Woolford, as well as papers by Campbell, 1988; Greenberg, 1989; Nichols, 1990)⁷. Without citing archaeological evidence (other than skeletal remains), Greenberg and colleagues concluded that the Inuit ancestors date to 4000 yBP, the Na-Dené speaking ancestors to ca. 9000 yBP (with a later migration to the U.S. Southwest within the last millennium), and the ancestors for the rest of the Americas to a single migration more than 11,000 yBP⁸. At the heart of the reasoning for these migrations was an unwritten argument: the Americas are diverse, but most of that diversity (except in the high northern latitudes) developed *in situ*, after the founding population(s) arrived. Later migrations brought further diversity, but this was geographically circumscribed and isolated from the majority of the Americas. Perhaps the paper written by Greenberg, Turner and Zegura (1986) was a harbinger, a symptom, or a proponent of the new debate that soon gained momentum on the origins, migrations, and settlement of humans in the Americas, as researchers reported on new sites and developed new sources of data. Indeed, as noted by Mulligan et al. (2004, p. 298), the “three migration theory gained steam [after its publication] and remains one of the main tenets against which questions are formulated and data are interpreted today.”

⁷ It is additionally notable that even one of the coauthors of the Greenberg et al. (1986) paper expressed misgivings very soon after the initial paper’s publication, albeit in a non peer-reviewed journal (Zegura, 1987).

⁸ The dates were determined by glottochronology, a practice that, while of merit, lacks the empirical testability that molecular and skeletal data present. Divergence times among languages are potentially hyper-variable, and assigning divergence times among languages is difficult and dependent entirely on the initial identification of language groups (Nichols, 1990; Nettle, 1999). Furthermore, authors have cited difficulties in correlating genetic with linguistic (or any other cultural) data, given their effective independence and inherently different modes of transfer (vertical versus horizontal) (Monsalve et al., 1999; Hunley and Long, 2005).

Also compelled by the results of Greenberg et al. (1986), by the irregularity of archaeological evidence and its interpretation, and by the advent of new techniques, geneticists have sought evidence to clarify the relationships among more recent New World populations and their common ancestry. Beginning with three limited studies (Schurr et al., 1990; Ward et al., 1991; Torroni et al., 1992), researchers have begun focusing attention on mitochondrial DNA (mtDNA) variation in the Americas, shortly followed by Y-chromosome studies (Torroni et al., 1994; Pena et al., 1995) and continued analyses of blood groups (e.g., Salzano, 2002; Uinuk-ool et al., 2003). Of these, however, the preponderance of papers published on this topic rely on mtDNA evidence. This is unquestionably the fastest-changing area of research in the origins of humans in the Americas, with dozens of publications each year arguing various hypotheses about the number of lineages, affinities, origin populations, migrations, bottlenecks, and antiquity of human entry to the New World. It is little wonder that a number of synthesis papers have become common over the last few years in an attempt to make sense of the burgeoning literature (e.g., Eshleman et al., 2003; Mulligan et al., 2004; Schurr, 2004; Schurr and Sherry, 2004; Schurr, 2005; Smith et al., 2005; Karafet et al., 2006; Merriwether, 2006; Zlojutro et al., 2006).

Why is there a focus on analysis of mtDNA, or, more specifically, on the hyper-variable 1 (HVRI) noncoding control region (the so-called D-loop)⁹? The genetic argument is often that mtDNA represents a non-combinatory, regularly mutating, and well-mapped (sequenced) locus (Merriwether and Ferrell, 1996). However, it should be noted that there are serious questions about mutation rate frequency (e.g., Bianchi et al., 1995; Kemp, 2007) as well as the possibility that some D-loop regions are “mutational hotspots” (Bandelt et al., 2003). The practical argument is that polymerase chain reaction technology has made

⁹ See Merriwether, 2006, for a good explanation of mtDNA appearance, function, and analysis.

mtDNA isolation and sequencing relatively easy and highly replicable, although contamination of specimens by foreign mtDNA continues to be a problem (e.g., Yang and Watt, 2005). As mtDNA is (effectively) only passed maternally through mitochondria in the oocyte, it also represents a single lineage of females. This latter point is an admitted downside to the usage of mtDNA data, as it fails to preserve the lineages of any females that bore only males, and thus is the reason why researchers have started to consider both mtDNA and Y-chromosome (which is only passed among males) evidence together (Schurr and Sherry, 2004). There is general incongruence between the lineages and affinities revealed by mtDNA and Y-chromosome data (Bolnick et al., 2006), which is not surprising given the variation in mating patterns that exist and have existed among human populations.

Placing these concerns aside for the moment, what has the mtDNA suggested about human origins in the New World? Early studies discovered four broad groups of sequence variants in the D-loop, termed “haplotypes,” among living indigenous populations in the Americas. Haplotypes with one or more shared mutations that arose from common ancestry are defined as haplogroups, four of which were identified in the Americas in the early 1990s: A, B, C and D (Ward et al., 1991; Wallace and Torroni, 1992; Horai et al., 1993; Torroni et al., 1993b). Researchers have used these haplogroups to argue that, at most, four migrations contributed to the population of humans in the Americas, each of which experienced a severe population bottleneck. Torroni et al. (1993a) also reported that all of the haplogroups except B could be identified among Asian living populations, but not in the same ones. Given this rarity, Torroni and colleagues implied that this evidence argued for multiple migratory events from different regions of Asia, although they admitted to under-representation of Siberian diversity in their sampling. Limited studies of other sources of genetic information, such as

Gm immunoglobulin allotypes, further supported the assertion that multiple colonization events took place or highly variable migrant groups entered the New World (Schanfield, 1992).

Cautions to these conclusions were published shortly thereafter. Noting the nearly ubiquitous prevalence of the four haplogroups across the New World, in addition to then-recently discovered new haplotypes (e.g., X7 and X6), Baillet et al. (1994) argued that no such bottleneck occurred, but that a limited number of haplogroups were present in the initial group(s) to populate the Americas¹⁰. Researchers of Y-chromosome diversity eventually also argued for no bottleneck (Underhill et al., 1996). Around the same time as Baillet et al.'s (1994) paper, Torroni et al. (1994b) identified the “missing” B haplogroup among living displaced Mongolians, confirming that all of the groups identified in the New World were present among extant Asian populations, though at different frequencies (Neel et al., 1994). Also within a couple of years of these initial publications, comparisons of the presence of these haplogroups among Asian populations guided some authors to the conclusion that, given the rarity of the haplogroups in Asia and apparently limited gene flow among regions of the Americas (e.g., Merriwether et al., 1993), it was unlikely that more than one founding population could have brought them all across from Asia (Merriwether and Ferrell, 1996). As Kolman et al. (1996, p. 321) wrote, “the statistical and geographic scarcity of New World haplogroups in Asia makes it improbable that the same four haplotypes would be drawn from one geographic region three independent times.” Of course, this would not preclude drawing individual haplogroups from *separate* regions or distinct, non-interbreeding populations from

¹⁰ It is important that, a decade later, Mulligan et al. (2004) reiterated the same conclusion, based on more genetic evidence; the same genetic diversity most likely existed before the documented historical genetic bottleneck caused by European contact in 1492 as that which exists today in the surviving populations (Bolnick and Smith, 2003). Note, however, that the recent description of haplogroup M in two mid-Holocene skeletons from British Columbia may introduce some doubt in this assertion (Malhi et al., 2007).

a single region, but it is unlikely that random genetic flow between both sides of the Pacific Ocean would yield a predominant combination of these haplogroups within most New World and a few East Asian populations, especially if no bottleneck occurred in the colonization of the New World.

Thus, within four years of the first publications concerning mitochondrial DNA evidence for the origins of peoples in the Americas, the stage was set for the modern debate among geneticists that persists even as more genetic data are gathered. The principal current deliberation continues to be over the specific origin and number of colonizing populations that migrated to the New World, paralleling the debate occurring among archaeologists. After the arguments by Neel et al. (1994) and Merriwether and Ferrell (1996), authors using additional evidence found close genetic similarities among humans in the Americas with central Asian populations, especially those from Mongolian regions and southeastern Siberian regions (e.g., Lake Baikal) (Kolman et al., 1996; Novick et al., 1998; Karafet et al., 1999). Karafet and colleagues, however, argued that the Y-chromosome data indicated at least two paternal lineages *from separate origins* within Asia contributing to all of the populations of the Americas, a result further argued by Lell et al. (2002). A minority of mtDNA researchers, examining haplogroup distributions across North America, also recognized two general divisions, separating the lower-latitude “Amerinds” from the high latitude Na-Dené and Inuit (Forster et al., 1996; Bonatto and Salzano, 1997a; Rubicz et al., 2003; Zlojutro et al., 2006). These mtDNA researchers, though, could not agree if the absence of certain haplogroups existed as a result of separate Asian migrations into North America, or *in situ* divergence of these two broad populations (e.g., Bonatto and Salzano, 1997b). Part of this argument has been the discovery of low frequencies or absence of some

haplogroups in extant high latitude North American populations (Shields et al., 1992; Lalueza et al., 1997). Similarly, further complications to the single migration hypothesis also arose from new research in South America, which identified missing haplogroups (namely, A, B and X) among Southern Cone groups in Patagonia and Tierra del Fuego (Moraga et al., 2000; Demarchi et al., 2001; Dornelles et al., 2005). This analysis of Y-chromosome data supported the idea that groups from Tierra del Fuego represented a genetic isolate, either resulting from early divergence or a founder effect (Fox, 1996; García-Bour et al., 2004). A number of authors contended, and continue to argue, that all of the mtDNA haplogroups found in extant New World indigenous populations were present in the initial, founding population that migrated to the Americas, but continued to mutate into new haplotypes and were lost (or differentially associated) in some populations as a result of stochastic effects resulting from population fissioning (tribalization) and movement (Malhi et al., 2002; Silva et al., 2002; Bortolini et al., 2003; Malhi et al., 2004; Zegura et al., 2004; Kemp et al., 2007).

Mitochondrial DNA and Y-chromosome modeled mutation rates have also been questionably employed to extrapolate the timing of the first migrations into the New World, with most researchers estimating a range of 22,000 yBP to 15,000 yBP (Horai et al., 1993; Torroni et al., 1994a; Stone and Stoneking, 1998; Silva et al., 2002; Bortolini et al., 2003), though some estimated dates are as early as 30,000 yBP (Wallace and Torroni, 1992; Bonatto and Salzano, 1997b). Forster et al. (1996) agreed with the former range for an initial migration, and additionally calculated an entry of 11,300 yBP for the Na-Dené and Inuit ancestral divergence. Most researchers noted that their own methodology for estimation is prone to error (e.g., Torroni et al., 1994a; Seielstad et al., 2003); the number of migrations must be known (to properly calculate the coalescence time among the haplotypes under

analysis), and sample biases can impact the results significantly (Mulligan et al., 2004).

Short temporal divergence periods among descendent groups from their ancestral origin are also more subject to genetic drift and mutation, and, if the research of Mishmar et al. (2003) is replicated, then natural selection may be playing a role in regional mtDNA variation¹¹.

Kemp et al. (2007) have further brought attention to the likely inaccuracy of these estimates, citing problems with using the phylogenetic, long-term rates of neutral mutation in mtDNA (which are employed, for instance, in the human-chimpanzee divergence estimation) to calibrate short temporal rates of D-loop mutation, contrasting these with pedigree-derived estimations of rates of mutation. Both Kemp et al. (2007) and Malhi et al. (2002, 2007), using ancient DNA (as opposed to most previous studies, which used DNA of living groups) have demonstrated that greater diversity of haplogroups (i.e., more haplotypes) was present in pre-Columbian skeletons from the Americas—even among potential founding populations—than has been accounted for by examining modern surviving populations. Again, as noted by some authors estimating origin times, if not all haplotypes are accounted for in estimations of divergence time, then resulting time periods are problematic and likely inaccurate. (An alternative method—determining coalescence for genetic haplotypes in a network using the ρ statistic—is far less sensitive to missing haplotypes.) Kemp et al. (2007) have offered a revised estimation of haplogroup convergence of variants to ca. 13,500 yBP, based on the increased knowledge of sample diversity, but this does not include haplogroup X (or its variants) or the recently-identified haplogroup M. Perhaps conveniently, this date more closely aligns with the earliest anticipated dates cited by existing archaeological evidence. The 95% confidence interval for the estimate by Kemp et al. (2007) is quite large

¹¹ Interestingly, Mishmar et al. (2003) suggested that *climate* is a major selection factor in mtDNA variation, though this may be a spurious correlation arising from associations of certain single locus (i.e., point) mutations with broad climatic zones.

(8,113 yBP to 28,667 yBP), though, and encapsulates the oldest proposed dates by previous genetic studies and by archaeologists arguing for a migration during (or just before) the LGM. Kemp (personal communication, 2007) acknowledges that these dates are not conclusive, but the more important implication they provide is that basic assumptions about using genetic data to estimate divergence time need to be evaluated, rather than blindly applied to all mtDNA or Y-chromosome data. Perhaps the most important argument from these dates, however, is that they only represent when a genetic divergence took place, and not the actual date of migration.

Although Kemp, Malhi and colleagues (members of the David Glenn Smith lab at UC – Davis) are certainly on the right track in critically thinking about the assumptions made by other geneticists over the last fifteen years, there is still much more genetic data to be acquired before asserting how genetically diverse humans in the pre-Columbian New World were. Some critical conclusions may be drawn from the research performed to date, however, many of which have been stated by Merriwether (2002) and Mulligan et al. (2004):

- Based on ancient mtDNA and its comparison with the mtDNA of living populations, the earliest inhabitants of the Americas were already as genetically diverse, if not more diverse, than modern groups from the Americas.
- Modern genetic diversity, however, is low compared to global variation because not much diversity survived from the initial peopling of the American continents. As stated by Mulligan et al. (2004), “European contact did not leave a large imprint on the level of Native American genetic diversity because genetic diversity was already substantially reduced by the early migrations....” Depopulation after European contact was asymmetric among regions (Dobyns, 1983), but no more haplogroups are

found in less decimated indigenous populations. This, in turn, might support either a single migration or multiple migrations, many of which may have introduced other haplotypes from Asia that did not survive post-Columbian population nadirs. The latter is unlikely, based on the preponderance of genetic evidence from living and archaeological DNA. Malhi et al.'s (2007) discovery of a sixth haplogroup, not yet identified among extant populations, may belie this point, but it is hardly parsimonious to start identifying multiple migration events from Asia based on currently unidentified Old World haplogroups in the New World.

- The number of migrations from the Old World that gave rise to the diversity in the Americas cannot be determined definitively, but the available evidence does not exclude the possibility that one migration event could have provided all of the genetic variation necessary to yield the genetic diversity of the modern New World. Until a better understanding of early population demographics is developed, however, any cited number of migrations based on genetic evidence alone remains speculative.
- Perhaps the most important point from the genetic research is that all humans in the New World were derived from Asian ancestors. Although there is a temptation to point to a single geographic location (e.g., the Altai or Lake Baikal regions) as the “homeland” of all indigenous New World populations, this is erroneous and imprudent. Asian groups likely neither remained in the same location since their offshoot populations colonized the Americas, nor did they cease to experience mutations and changes in their alleles (e.g., population stability and stasis).

Do skeletal data clarify the archaeological or genetic evidence? Attention has been almost exclusively focused on comparing crania from the Americas with the Old World, and

prior to the work of Howells (1973), a great amount of this was descriptive and typological¹² (Howells, 2006). Over the last few decades, research has continued to focus on cranial morphometric and dental trait analyses in this context, and generally has been limited to identifying the affinities of the earliest skeletons found in the Americas. In two isolated studies, researchers have also compared postcrania among these early skeletons (Hall et al., 2004; Powell et al., 2004), though, given their fragmentary nature, no other studies have been conducted on postcrania. The results of Hall et al.'s analysis will be discussed in Chapter 3.

An important aside: researchers have taken to calling these skeletons “Paleoindians,” “Paleoamericans,” “First Americans,” and other, similar terms, all of which are, frankly, scientifically inaccurate. They assume that the skeletons from before 8500 or 8000 yBP (a criterion used, for example, by Powell and Steele, 1993) are representations of the first population(s) to colonize the New World, even though they postdate the oldest archaeological sites by at least 2000 years. Powell (2005) has noted that, based on the few archaeological materials found with the skeletons, they represent more than one subsistence mode. This parallels the arguments by archaeologists regarding technological diversity early in the archaeological record (see above), which suggests that referring to all of these skeletons by the same general name is misleading. In addition, very few date from the temporal period or have been found with the tool industries that archaeologists designate as “Paleoindian,” confusing the matter further. Finally, and most importantly, “Paleoindian” implies ancestry among these skeletons to more recent indigenous humans in the Americas, when their affinities have not yet been worked out (one way or the other). In a political move, researchers have taken to using the other terms to minimize this assumption, but, as

¹² For an example of this previous typological approach, see Hooton's 1937 paper.

stated, such alternative terminology is itself subject to assumptions. For these reasons, these skeletons are referred to as early Holocene skeletons, because, simply, this is what they are.

There are currently fewer than one hundred individuals¹³ dating from the early Holocene (before 8000 yBP, not including burials from the Windover Pond site in Florida, which has a mean antiquity of 8100 yBP) represented by human remains in the New World (Powell, 2005). Of these, only a few have intact crania available for comparative analyses, and different samplings of these crania have been employed in investigations. Namely, those that have been used include Kennewick (Washington), Buhl (Idaho, repatriated), Spirit Cave (Nevada), Wizard's Beach (Nevada), La Brea (California), Browns Valley (Minnesota, repatriated), Warm Mineral Springs (Florida), Horn Shelter (Texas), Peñon III (central Mexico), Tlapacoya I (central Mexico), Lapa Vermelha (Brazil), Sumidouro (Brazil), Capelinha II (Brazil), Lagoa Santa (Brazil), and Dos Coqueiros (Brazil), the majority of which represent males and, with the exception of Sumidouro Cave, are isolated individuals (Powell and Neves, 1999; Jantz and Owsley, 2001; González-José et al., 2005; Nelson et al., 2005; Neves et al., 2007). No analysis has examined all of these crania simultaneously (mostly for practical reasons, such as access to specimens), and comparisons made with more recent indigenous New World specimens often rely on the individuals measured by Howells (1989), therefore limiting the total diversity of the represented Americas¹⁴ (e.g., González-José, 2001; Neves et al., 2004).

Analyses comparing craniometrics of the earliest crania, in general, argue for

¹³ This is likely an underestimate: skeletons in collections, such as the 31 specimens from Sumidouro Cave in Brazil (Neves et al., 2007), have been recently redated to before 8000 yBP.

¹⁴ This problem is cited only rarely, and somewhat dismissed, by authors comparing these crania. Some have sought to augment the geographic representation of the Americas by supplementing the available data with their own measurements of additional samples (e.g., Jantz and Owsley, 2001) or aggregating data from other sources (e.g., Powell and Neves, 1999).

considerable phenotypic diversity. Steele and Powell (1994), in one of the first craniometric studies (which therefore lacked crania later found to date to the early Holocene, such as Nevada specimens and Kennewick), found that the range of variation among early Holocene North American crania “does not differ significantly from the ranges present in larger and more recent comparative samples” (p. 143), although their means for assessing this are never described. Later studies, however, incorporating more early crania from North America and adding South American individuals, argue for even greater heterogeneity (Nelson et al., 2005) and for distinctive facial and cranial shape (smaller, more prognathic faces coupled with dolichocephalic—or long headed—neurocrania) compared to more recent New World samples (Neves and Hubbe, 2005). Both of these trends are used by Jantz and Owsley (2001) to argue against pooling the earliest crania in comparative osteological analyses. Much of this variation may be due to genetic drift and founder effects, though recent analysis by Pucciarelli et al. (2003) indicated that some potentially adaptive changes occurred among these early inhabitants in response to diet and other environmental factors, a concept examined extensively using the extreme morphology of the populations from Tierra del Fuego (Lahr, 1995; Hernández et al., 1997), whose crania reflect a mixture of adaptations to masticatory stress and, somewhat, to a colder climate (Bernal et al., 2006).

More recent crania show this diversity as well in the Americas, especially South America. Ross et al. (2002), for example, examined pre-Columbian and historic crania from a variety of populations, mostly focusing crania from southern North America and northern South America. Their analysis revealed that the degree of heterogeneity within the pre-Columbian samples exceeded those of more recent (European) comparative samples, potentially arguing for more isolation and microevolution among these earlier populations.

Sardi et al. (2005), using a sample of recent South American populations from the Southern Cone, echoed this finding of high amounts of variation, and argued that this resulted from early splintering and isolation among colonizing populations. Dillehay (2000) and many of the authors contributing to *Foragers of the Terminal Pleistocene in North America* (Walker and Driskell, 2006) have made arguments that the environments into which humans migrated in the Americas during the late Pleistocene were rapidly changing and unstable. Citing these conditions, Sardi et al. (2005) conjectured that, as groups migrated and separated, small population sizes, genetic drift, and (to a small extent) adaptation modified the morphologies of the founder population to create the more recent observed diversity. A crucial component in their argument, however, is that the indications of phenotypic variability (F_{ST}) in craniometrics are high among these South American populations, which in turn would implicate small effective population sizes (Deka et al., 1995) or a deep antiquity for the populations considered (Sardi et al., 2005). González-José et al. (2001) also found higher levels of phenotypic variability among South American samples compared with variation among North American samples, though their South American sample was more geographically diverse. If their results are accepted, they could further argue for more population divisions or greater time depth among South American populations compared with North American populations. Their results contrast somewhat with those previously reported by O'Rourke et al. (1992), who found generally similar and overall lower amounts of variation in both North and South America, though their sample was even more limited. Jantz (2006), employing the Boas anthropometric data (see Chapter 1), noted regional variation in the F_{ST} values for North American groups (in part potentially related to decimation in post-Columbian times), but generally showed high amounts of variation

between populations relative to within population variation in six head and face measurements, comparable to those demonstrated by the more limited North American sampling of González-José and colleagues (even though the data are not directly comparable). Indeed, Jantz (2006, p. 787) further demonstrated that the variability among North American indigenous populations is “a little over 75 percent of world variation” represented by Howells’ (1989) data, although he admits that phenotypic plasticity of the face may be artificially increasing this amount. A high F_{ST} for New World populations was found by Powell and Neves (1999) and by Ross et al. (2002)—one which they cite as exceeding the global values obtained by Relethford (1994)—lending credibility to the results indicated by Jantz. Regardless of how this compares with worldwide variation, there is sufficient evidence to show high amounts of variability among New World cranial shape and, recently, size (Jantz and Owsley, 2005).

Attempting to further assess the patterns implied by this craniometric evidence, researchers have examined dental traits in both the earliest and more recent crania from the Americas. Hanihara (1968) developed a suite of dental characters found among many of the populations of central and northern East Asia, termed “Sinodonty” by Christy Turner (1983)¹⁵, which contrasts with general dental traits of earlier and marginal populations from these regions, as well as with modern Southeast Asian groups, termed “Sundadonty.” The dental characteristics are claimed to be polygenic traits and highly heritable (Turner, 1985)¹⁶.

¹⁵ Note that, as explained in detail by Powell in his dissertation (1995, pp. 37-41), the combination of traits cited by Turner to make up the Sinodont complex has changed substantially since this 1983 publication.

¹⁶ The research of Nichol (1989) in assessing the heritability of the traits that signify Sinodonty was equivocal, though, suggesting that high incidence of the shoveling of incisors—perhaps the most obvious characteristic of Sinodonts—is possibly determined by a single recessive allele and may be affected by environmental factors. Clearly, shoveling is a common trait in both Asia and the New World; it has been documented by numerous researchers (e.g., Hanihara, 1992; Matsumura, 1995). Yet, if shoveling is polymorphic from a single genetic locus (or, at least, is not pleiotropic), then this reduces its stability as a non-metric trait by which to identify affinity.

Comparisons among Pleistocene and Holocene crania in Asia have established that Sinodonty developed after and from Sundadonty, and that the humans expressing the former replaced the latter throughout Northeast Asia (Turner, 1990). Therefore, the presence of both dental “types” among New World populations would argue for colonization by different founder populations.

In numerous publications (including being one of the coauthors in Greenberg et al., 1986), Turner has examined dentitions in recent and early Holocene crania and concluded that all exhibit the morphologies associated with Sinodonty (Turner 1985; Turner and Bird, 1981). Following Turner’s assessments, however, other researchers have noted that not all of the Sinodont traits were equally present among New World populations (i.e., they exhibit a mosaic of trait combinations), and are absent in many of the earliest crania as well as in certain populations, such as those from Tierra del Fuego (Powell, 1993; Lahr, 1995; Haydenblit, 1996; Powell and Rose, 1999; Powell 2005; Sutter, 2007). Scott and Turner (2006) rebuffed their claims, however, stating that these individuals failed to account for dental wear in their trait scoring, the validity of which Powell and Sutter have denied (personal communications, 2006 and 2007). In fact, Powell (1993) criticized numerous aspects of Turner’s methodology, citing assumptions made concerning dental heritability, the amount of evolutionary time represented by dental differentiation, and the pooling of temporally and geographically diverse samples into “populations” for study (though Turner justifies the latter assumption in his 1985 *Out of Asia* chapter).

With such a small number of researchers examining these dental characters currently in a wide sample (temporally and geographically) of New World crania, and given the typological nature of these dental traits, it is difficult to assess conclusions based on the

published results. It is interesting to note, though, that with the consensus of researchers examining craniometrics who have concluded that high amounts of variation have typified New World populations throughout the Holocene, it is surprising that dental variation would be low (even though these are not linked cranial phenotypes). Additionally, if the early Holocene crania *do* represent a group (or groups) that is (are) phenotypically distinct from more recent indigenous populations, and dental traits that typify Sinodonty are present among all these early crania (a claim refuted by a growing number of researchers), then the tooth morphologies are highly heritable (cf. Nichol, 1989) or the cranial variation reflects non-heritable variation. The latter is unlikely, given the available evidence concerning phenotypic variation in the cranium—namely, that portions of cranial morphology have been shown to have high heritability (e.g., Relethford, 1994; Carson, 2006).

What does the ancient and more recent morphological variation in crania (including dental traits) reveal concerning the origins of New World populations? Unfortunately, the available data are equivocal, and could support a single or multiple colonizing events. Using the arguments for population fragmentation while colonizing unstable environments and possible uniformity (or limited variation) in dental morphology, it is possible to conclude that a phenotypically diverse population (or group of populations) moved into the Americas in a single migratory event. The amount of phenotypic diversity in the earliest inhabitants could have been substantially lower than that observed among the Early Holocene crania, especially if this population predated those crania by millennia and experienced the effects of genetic drift and founder effects while differentially encountering genetic barriers and gene flow as they colonized the New World (Powell and Neves, 1999). The support for this scenario, however, is reduced when considering that it would require a breeding population

of some size or a very high reproduction rate (Powell, 1997), as well as a slow enough rate of territorial expansion and population fissioning to maintain reproductive viability (Fix, 1999, 2002), both of which would have been difficult in highly unstable environments (Surovell, 2000). The descriptions of dental trait variation departing from the “Sinodont” pattern cannot be ignored, and point to the presence of early colonizers that either convergently developed many of the Sinodont traits or were replaced/experienced gene flow with later Asian migrants (Lahr, 1995). In addition, the cranial variation present among the known early Holocene skeletons generally clusters closer to Southeastern Asian or Oceanian groups (likely descendants of Pleistocene southern and central Asian populations) and away from more recent New World samples in multivariate analyses (e.g., González-José et al., 2001; Jantz and Owsley, 2001), whereas more recent New World groups are generally heterogeneous. Taken into consideration together, these objections to a single, early migration model imply at least one additional migration, giving rise to the late Pleistocene and early Holocene inhabitants.

Consistently for over a decade Walter Neves, in examining early Holocene crania from Brazil, has been at the forefront of the argument that at least two groups from Asia populated the Americas, based on the affinities of early crania with more “gracile” and “non-Mongoloid” crania from late Pleistocene Southeast Asia and their descendants (namely, Australian aboriginal populations) and the lack of this morphology (i.e., the presence of “Mongoloid” characteristics) in more recent samples from the Americas (Neves and Pucciarelli, 1991; Munford et al., 1995; Neves and Pucciarelli, 1998; Neves et al., 1999; Powell and Neves, 1999; Powell et al., 1999; Neves et al., 2003; Neves et al., 2004; Neves and Hubbe, 2005). This dichotomy has been supported independently by Steele and Powell

(1992) and Brace et al. (2001) for South Americans, and by Jantz and Owsley (2001, 2005) for North American early Holocene crania. Genetic studies that identified distinct differences (namely, missing haplogroups) in mtDNA and Y-chromosome sequences among South American groups—especially the geographically isolated and morphologically distinct populations from Tierra del Fuego—have provided supporting evidence for Neves’s model (Lalueza et al., 1997; Moraga et al., 2000; Demarchi et al., 2001; García-Bour et al., 2004; Dornelles et al., 2005). Fiedel (2004), however, has erroneously criticized the results of the skeletal biologists’ analyses as reversions to typological assignments of New World variation to specific Old World sources (e.g., Hooton, 1930, as cited by Fiedel, 2004). Fiedel argued that the association of early Holocene crania from South America to crania from Zhoukoudian and Australia (effectively, “Sundadonts”) is misleading at best, and not even marginally supported archaeologically, but he is taking the ideas of Neves and colleagues too literally. Neves actually has recently addressed this criticism directly, and in his explanation succinctly summarized his two-wave migration model (Neves et al., 2007, p. 29):

The detection of an “Australo-Melanesian” pattern of cranial morphology in the Americas...can be easily explained without involving any sort of transoceanic crossings. As we [Neves and Pucciarelli] have emphasized...northern Asia can be easily maintained as the point of departure of the Paleoamericans.... It has been amply demonstrated that during the Pleistocene, Asia was also occupied by humans with a cranial morphology similar to that seen among the first South and Central Americans. The cranial morphology that predominates today in east Asia (and in the Americas) is certainly a late evolutionary phenomenon dated to the Pleistocene/Holocene transition (Kamminga and Wright, 1988; Cunningham and Jantz, 2003).

Within Fiedel's (2004) commentary, however, was a more fundamental issue that is obvious after reviewing the multiple sources of evidence, hypotheses, and conjectures summarized in this subsection. The evidence offered by archaeologists and biologists is experiencing a rapid, methodological development that has the potential to provide a multidisciplinary perspective on the emergence of humans in the Americas. The rapidity of publication (especially in genetic research) and influx of new researchers, however, has a double-edge quality. Unlike a century ago, when specialists in all anthropological disciplines could convene to discuss the origins of New World indigenous populations, it is growing more difficult for modern researchers to maintain the awareness, let alone the expertise, to critically evaluate the evidence from these myriad sources in order to develop more holistic models. I cannot guess the source of what Neves refers to as Fiedel's "misconstrual of [his] ideas", but Fiedel is correct in pointing out that some skeletal biologists and geneticists have taken to ignoring archaeological evidence in favor of their own hypotheses, often stating that archaeologists have just not found the supporting evidence yet. Perhaps this phenomenon is what Fiedel was attempting, in part, to address in his commentary. Indeed, no discipline investigating the evolution and diversification of humans can afford to ignore the evidence of other disciplines, especially as none has capital on more accurate evidence.

What, then, may be concluded from this review of the recent archaeological, genetic, and skeletal data about the origins of New World populations? Without any ambiguity, the inhabitants of the Americas came from Asia. Archaeology, genetics, and craniometric studies all support this conclusion, even though connection between the microblade or bifacial flaking technologies of western and eastern Beringia with those of lower latitudes is not resolved. Currently, the earliest evidence for human colonization of the Americas places

migration model initial dates between roughly 15,000 and 14,000 yBP, though movements into the Americas during earlier millennia are still an option (though generally unsupported). The number of populations, migrations, or factions cannot be ascertained, though it is possible that the Americas could have been colonized in as few as one or two migration events (or a series of small, temporally confined migrations). Studies by linguists, which have not been reviewed in detail here, relate languages to each other differently (e.g., Nichols, 1990, 2002; Ruhlen, 1994, 1998; Campbell, 1997), and have been used to argue for all possible numbers of original founding groups. Given the horizontal transmissibility of language (i.e., within generations and among unrelated individuals), and the possibility of multilingualism among the original inhabitants of the Americas (Nichols, 2002), this kind of evidence cannot be used to resolve the origin debate without devolving into conjecture.¹⁷

If any theme is clearly evident, though, it is that there has been a substantially great amount of diversity—in toolkits, subsistence practices, genetic groups, phenotypes, and possibly languages—starting with the first detectable New World populations. Indeed, there may have been as much, if not more variation in these elements among the earliest settlers as among their successors. It is still not possible to demonstrate whether this variation developed in Asia, en route, or within the Americas, but an emerging concept of early tribalization or group isolation among the first inhabitants cited by various researchers implicitly maintains diversification shortly *after* colonization. This is somewhat questionable given the widespread presence of the Clovis tool industry in North America (which is

¹⁷ There are generally two “camps” among linguists, represented by Ruhlen (following Greenberg’s ideas) and by Campbell, one of Greenberg’s earliest and most vocal critics (e.g., Greenberg, 1989). Discussing linguistic evidence, effectively, reduces to comparisons between linguists citing separate Old World sources for all major New World linguistic groups and those arguing for differentiation in the Americas, arising from a deep occupation or rapid splintering. In addition, geneticists have argued stridently against directly correlating language and biological variation (Monsalve et al., 1999; Rubicz et al., 2002; Bolnick et al., 2004; cf. Cavalli-Sforza et al., 1992); their suitability in resolving biological issues is therefore dubious (though as much could be argued of archaeology).

relatively homogeneous despite regional variations). However, the pervasive presence of Clovis does not preclude rapid cultural exchange or a complete replacement event in some regions. (Although some researchers cling to the argument that Clovis represents the sole founding population and migratory movements for the Americas, evidence of pre-Clovis sites points to humans living in the New World at least a short period before the appearance of Clovis.) Knowing these possibilities and the evidence reviewed above, the topics of migration routes and dispersal patterns can be critically addressed.

Routes and dispersals (How? To where? Using what?):

As noted, the New World late Pleistocene landscape into which humans migrated was a complex mosaic environment emerging in oscillating temperatures from an ice age (West, 1996; Dillehay, 2000). This was the case not only in subarctic regions, which were largely free of glaciers, but also—especially important concerning human entry into the New World—in the high latitudes. Continent-wide glaciations of the LGM started approximately 25,000 yBP (Elias, 2002); two large ice sheets (the Laurentide and Cordilleran) had largely coalesced and covered most of North America above fifty degrees latitude, effectively separating Beringia and Siberia from central North America terrestrially (Levson and Rutter, 1996). Current consensus among geologists and archaeologists is that the central and southern portions of eastern Beringia (Alaska) were deglaciated by the beginning of the Allerød (ca. 14,000 yBP) (Mann and Peteet, 1994; Hamilton, 1996; Heaton and Grady, 2003; Hill, 2006), as was the western coastal margin of Canada (Blaise et al., 1990). Researchers examining pollen, fossil, and geological evidence, furthermore, contend there is evidence that Pacific coastal shelf margins were ice-free during this period (especially during the Bølling warming interval 13,000 yBP) and characterized by cool temperate flora, short-term estuary

and riverine systems, and some terrestrial herd species, as well as migratory birds and marine mammals (Barrie et al., 1993; Mandryk et al., 2001; Fleming and Cook, 2002; Lacourse et al., 2005). In contrast, researchers examining the interior of North America have come to a consensus that the interior of Canada remained effectively impassable until ca. 11,400 yBP (Mandryk et al., 2001; cf. Haynes, 2005), with most regions uninhabitable due to aridity and lack of vegetation until after this time (Mandryk, 1996), with the possible exception of the most northwestern reaches of the edge of the corridor (Catto et al., 1996). The interior of eastern Beringia was likely equally as inhospitable, without trees or other readily-available sources of fuel for fires or the construction of shelter (with the exception of animal remains) until 11,000 yBP (Szeicz and MacDonald, 2001; Elias, 2002).

The debate over the number of migrations to the Americas is implicitly linked to the routes taken to reach the New World. As described earlier in this chapter, a basic assumption of the original “Clovis-first” model was that humans had migrated over land from Asia, through Beringia, and into the Americas via a glacier-free corridor in western Canada, pursuing migrating herds of ungulates and mammoths (Haynes, 1964). Citing a lack of archaeological evidence in this purported corridor for the period before the appearance of Clovis farther south, inhospitable conditions within the corridor (where it existed), and poor alignment of tool industries in Beringia with those in sub-glacial North America, Fladmark (1979), taking cues from geologists, expanded an alternative theory that humans migrated along the coast, most likely in watercraft. Over the three decades since he published his ideas, a debate has developed over whether humans migrated by land or by sea (e.g., Fiedel, 2000; Erlandson, 2002). As sagely pointed out by Mandryk et al. (2001), though, these

models are not mutually exclusive; humans could have traveled either inland on foot or along the coastline (taking advantage of watercraft and terrestrial movement).

Critics of the coastal migration hypothesis have generally leveled numerous objections to the plausibility of the coastal model. These generally fall into three categories: 1) there is no archaeological evidence of seafaring among humans in the Pleistocene, especially across the Northern Pacific, which may have involved movement against currents and wind direction; 2) there is no archaeological evidence that humans colonized the coast prior to the earliest sites inland; 3) the rejection of the Clovis-first or any inland migration depends on “negative evidence,” in that the only reason for a coastal migration hypothesis is the lack of clear evidence *currently* for inland migration (Erlandson, 2002). I will consider these in turn.

The first objection has become moot over the last decade. Corroborated archaeological data show that humans colonized a number of islands and the continent of Australia as early as 40,000 yBP (and likely much older for Australia), all of which required travel over tens of kilometers of open water, sometimes against currents¹⁸ (Oda, 1990; Matsumura, 1996; Allen and Kershaw, 1996; Mulvaney and Kamminga, 1999). The type of watercraft (e.g., rafts, animal skin boats, rudimentary sailboats, canoes) employed on these voyages is unknown because of their archaeological invisibility. Except in the most exceptional abiotic and anaerobic environments, preservation of the perishable plant and animal materials that were used in boat construction is unlikely. Ethnographic anecdotal evidence of pervasive use of multiple boat technologies by aboriginal peoples in North America (Driver and Massey, 1957) and worldwide (Jodry, 2005) lend support to the importance of watercraft to human subsistence and mobility not just in coastal settings, but anywhere in which large bodies of

¹⁸ The arguments concerning ocean currents and wind in the Northern Pacific are not persuasive, as the modern conditions along the northern Pacific Rim—prevailing western currents and harsh storms—may have been largely different with lower ocean levels, the Beringian landmass, and early interstadial weather distinctions.

water are traversable. It is notable (and perhaps not coincidence) that some of the early Holocene human remains in the Americas have been found near such water sources. For example, Spirit Cave and Wizard's Beach (near the ancient Lake Lahontan in Nevada), La Jolla (Baja California), On Your Knees Cave (Prince of Wales Island, Alaska), and Arlington Springs (Santa Rosa Island), the latter two located on islands that would have been separated from the mainland at the end of the Pleistocene. Indeed, some of the oldest human remains found in the Americas were found at Arlington Springs, supporting the early use of watercraft (Powell, 2005).

The second objection—the lack of coastal evidence for an early human presence—is a problem, but researchers are beginning to address it via two lines of study: paleoenvironmental reconstruction and archaeology. Paleoenvironmental studies have lent credence to the viability of the Pacific coastline in high latitudes during the Allerød warming cycle. Hetherington and Reid (2003) and Hetherington et al. (2003), in examining assemblages of fossil mollusks in regions that would have been intertidal zones near to the Queen Charlotte Islands (in the Pacific Northwest) at the end of the Pleistocene, found convincing evidence that the climatic conditions were suitable for human habitation by 13,500 yBP (including the “productivity of nutritious intertidal mollusks,” p. 644, Hetherington and Reid, 2003). No reliable evidence exists, however, to show that humans were consuming mollusks, and some authors have contended (on limited evidence) that the exploitation of this marine resource did not occur until the mid-Holocene in the Pacific Northwest (Yesner, 1998). However, the presence of brown bears—large omnivores with similar nutrition requirements as humans—in southeastern Alaskan sites on Prince of Wales Island dating from 14,000 yBP support the conclusions of Hetherington and colleagues

(Heaton, 1993). Some early Holocene archaeological sites in the northwest Pacific coast of North America have also been described, dating to before 10,000 yBP (e.g. Carlson, 1996; Erlandson et al., 1996; Fedje and Christensen, 1999; Dixon, 2002). These have been located along coastlines that have been determined to have shifted little since the increasing ocean levels, and so are more likely to be preserved. Other archaeologists, searching intertidal zones that had been coastline 10,000 years ago, have found stone tools in assemblages (and not isolated) below the sediment, implying a habitation site or tool cache (Josenhans et al., 1995). Many of these tools are characterized as microblades, and found to resemble lithics in southeastern Alaska (though whether these microblades are similar to technologies found in Kamchatka or central Alaska has not been stated by any of these authors). Dixon (1999), in examining these blades, stated that they are evidence for a specialized marine hunter-gatherer subsistence that had taken time to develop, implying longer habitations at these sites or a deep maritime adaptation (perhaps both) among the populations the tool industries represent. Mandyrk et al. (2001) also report the presence of large bifaces in Haida Gwaii, an archipelago off the coast of British Columbia, in layers below those in which microblades have been found, providing some tenuous support for Dixon's viewpoint. Finally, a site along the southern coast of Oregon (Indian Sands) dating to ca. 10,400 yBP exhibits clear signs of habitation and implies the presence of long-distance trade networks, based on the presence of exotic obsidian lithics at the site (Davis et al., 2004). Together, these archaeological discoveries are providing substantiation for the conjecture that humans were living along the coastline of North America—from Alaska to the Channel Islands—by 10,500 yBP, and likely much earlier. As the search for these coastal sites is still at its most rudimentary stages, it is likely that more evidence will be uncovered that will indicate if these

marine hunter-gatherers were recent inhabitants at the very end of the Pleistocene, or represent a longer habitation.

Given these two sets of related data, the conclusion that many researchers are drawing is that humans were adept at moving along coastlines and, in some cases, across open ocean, prior to the earliest time period estimated for the migration of humans to the New World. It is a feasible possibility that humans migrated into the Americas via the coast as soon as the Last Glacial Maximum began to recede. Indeed, based on the archaeological and geological evidence, this was the only available route until roughly 11,500 years ago; recent analyses have demonstrated that, while the Cordilleran Ice Sheet continued to coalesce with the Laurentide inland, it had ceased to protrude out to the coastline toward the end of the LGM (Lacourse et al., 2005). Given the presence of humans in Monte Verde by 12,500 yBP, a coastal migration becomes the most feasible, if not the only route available. So, the third argument by critics—that the rejection of the migration through the interior route is based on “negative evidence”—is completely unviable. Easton (1992) attributed this rejection by some archaeologists of support for a coastal migration hypothesis to a fundamental paradigmatic bias, one which more recent researchers have declared all but negated (e.g., Fix, 2005; Jantz and Owsley, 2005).¹⁹

Humans did eventually travel between Beringia and the subarctic by land. Some Clovis sites have been found toward the southern range of the modeled glacier-free plains of central western Canada that occurred after 11,400 yBP (Haynes, 2005), though the earliest Clovis

¹⁹ Archaeological studies, by their nature, rely on the development of models from often scant evidence. The downside of this practice, however, is the employment of *deductive* reasoning among researchers, as models are formulated and either supported or rejected by new evidence. In this paradigm, though, rejection of models results in wholesale rejection of hypotheses, and do not necessarily allow for their modification. Some archaeological studies, moreover, focus on making the archaeology fit a preconceived model, which leads to multiple interpretations from the same empirical evidence. For this reason, it would be more useful to practice inductive reasoning in the assimilation of archeological and geological evidence, adding together the available evidence to create alterable hypotheses.

sites remain in Texas (Collins, 1999; cf. Bradley and Stanford, 2004). It is not possible to determine if the Clovis lithic technology found in Canada resulted from populations moving from the northwest, or from the south. It is possible that, under what has been termed the “blitzkrieg” model of migration (Martin, 1973; Whittington and Dyke, 1984), humans moved rapidly through this interior region and therefore would have left few archaeological traces (Dumond, 1998). This idea is based on the conjecture that humans would have desired to move quickly through the resource-scarce environment, while following herds (Haynes, 1964) or even flocks of migratory fowl (Fiedel, 2006), and has been justified by the rapid spread of Clovis points (Fiedel, 1999; Waters and Stafford, 2007) or by parallels with later quickly-spreading groups, such as the Thule (Fiedel, 2000). However, these assumptions are unsupported:

- If humans were heavily dependent on megafauna, it would have been difficult to maintain a large group of people given likely faunal scarcity (even assuming that the migrants were adept hunters) (Byers and Ugan, 2005). More recent descriptions of Clovis sites demonstrate the presence (if not predominance) of smaller prey (e.g., Kelly and Todd, 1992; Meltzer, 2002), implying that the diets of these early foragers and hunters was broad and adaptive. (Which calls into question the ecological “pull” factor that would have driven humans from Beringia southward at this time period.)
- Ecologically and practically, it also would have been highly difficult (i.e., energetically costly) for humans to have survived in the shrubland that Mandyrk (1996) determined would have existed in central Canada during the late Pleistocene, especially as they would have been traveling into unfamiliar territory (Anderson and Gilliam, 2000). Comparisons with more recent examples of rapid migrations that

- occurred through hazardous territory, such as the Thule expansion in the arctic, are inappropriate, as the Thule expansion *replaced* a previous human inhabitation (the Dorset culture) and was largely restricted to coastal migration by a culture whose hallmark was coastal adaptation (Darwent and Smith, 2006).
- Highly mobile groups of hunter-gatherers can have high reproductive rates (Surovell, 2000), but this is dependent on a regular, predictable source of food and resources. Kelly (2003) noted that, if humans were introduced into an environment wherein prey were “naïve” about the predatory nature of humans, the humans would have had a short-term hunting advantage. However, prey species adapt, and given the projected scarcity of megafauna (Byers and Ugan, 2005), this could have produced catastrophic results on the regular availability of resources.
 - It is not known if Clovis represents a single culture or if it represents cultural exchange, so it cannot be cited as an example of migration of a single group (Rogers et al., 1992, cf. Meltzer, 2002).

Fix (1999, 2002) and Beaton (1991), in modeling population viability in various colonization scenarios, argued strongly against the “blitzkrieg” or any other rapid inland (or coastal) migration model. Maintaining breeding diversity and combating the likelihood of extinction due to low population densities were among their greatest doubts in the model’s probability. Without breeding diversity, allele frequencies would have been fixed rapidly among the founding population(s). It has already been established that much of the genetic diversity present in the earliest migrants is present in living New World populations (Kemp et al., 2007), and that genetic diversity observed is, largely, not geographically patterned in any way that would imply regional founder effects (with the exception of the southern cone

of South America and the arctic) (Lorenz and Smith, 1996). Therefore, unless a large population were involved in a rapid migration as a single group (unlikely due to ecological strain), a blitzkrieg model of inland migration could not have been the source of the diversity observed in the Americas.

Together, this evidence does not suggest that such rapid, low-density migrations could not have occurred, but that they were exceptions in the populating of the New World.²⁰ The coastal migration model, though, fits the criteria for maintaining population diversity, high breeding rates, and ecological stability better than inland models (Fix, 2005). Indeed, Fix's (2005) model for coastal colonization, though an informed conjecture, correlates well with the frequencies of mtDNA haplogroups A-D and X found in more recent New World populations, and conservatively moves humans from Beringia to southern Chile within 3,000 years (120 generations in his model), while also allowing for the gradual expansion of humans into the interior of the continents. Craniometric analyses also support this idea, showing that Pacific North and South American coastal crania from the first 4000 years of the Holocene bear similarities to other crania from the western side of the Pacific Rim (Jantz and Owlsey, 2005; Neves et al., 2007). Recent genetics studies also argue for longer lineages among coastal inhabitants and gene flow between them and more inland populations (Malhi et al., 2004; Kemp et al., 2007; cf. Eshleman et al., 2004)

One critique of the colonization model (Kelly, 2003) is that marine hunter-gatherers tend to be more sedentary than inland hunter-gatherers, due to better resource predictability. Yet, Mandyrk et al. (2001) preemptively suggested that rising sea levels, a phenomenon defining the period of colonization of the Americas, are a strong displacement factor. In addition, changing microenvironments, new technologies, and new resources would have driven

²⁰ Other, faster models have been proposed as well (e.g., Steele et al., 1998; Surovell, 2002).

further differentiation among groups, and could have drawn (“pulled”) populations from the coast into the continents via riverine systems (Anderson, 1990; Fix, 2005; Jodry, 2005).

Perhaps the most important perspective that is emerging from these ideas is that we cannot afford to subscribe to the primacy of any single hypothesis. Both coastal and land routes are possible and likely combined to yield the emerging observations of diversity in technologies and biology at the end of the Pleistocene. Humans traveling from eastern Asia could have brought a number of technologies with them, traveling both by boat along the Pacific Rim as well as over land when necessary or convenient.²¹ Yet, as argued above and by others (Hall et al., 2004), the coastal route is more parsimonious to explaining a human presence in Monte Verde, unless we resort to citing phantom lineages and currently unsupported pre-LGM archaeological dates. Humans could have migrated to the New World before 25,000 yBP, but archaeological and biological evidence are lacking (Madsen, 2004b).

The number of migrations is not resolved by this colonization model. It does support the possibility that a single group of humans traveled and along the coast and inland via rivers, fissioning but maintaining a breeding pool with neighbors, and giving rise to the various permutations of mtDNA haplogroup combinations within populations observed among modern indigenous peoples of the New World (Fix, 2005). It is also possible that more than one group migrated across coastal Beringia and replaced or interbred with groups that settled ahead of them (Neves, 2007), or that some groups that fissioned further north eventually yielded subsequent migrant groups moving south that interbred or replaced forerunners. If the Sundadont dental pattern is typical of the early Holocene crania (Lahr, 1995), and it is

²¹ Researchers will never be able to discern why these Pleistocene human groups were compelled to travel the extreme distances implied by such sites as Monte Verde and Meadowcroft. That these populations *did*, and that the fragmentary and widely distributed cultural (and much later, skeletal) remains may be found and properly recognized, is what matters under the new paradigm.

unlikely for the diversity of cranial shapes among these crania to have developed into more recent New World populations (Neves and Powell, 1999; Jantz and Owsley, 2001) then this would argue that at least two migratory movements took place from Asia to the Americas. Only with future archaeological, skeletal, and genetic evidence will the coastal migration model be refined and the number of colonization events resolved.

2.2: New waves on old shores? Movements after the first migration(s)

Humans remained mobile hunter-gatherers after arriving in the New World, though the amount of movement by groups likely decreased as numerous groups occupied the landscape and began to establish neighboring territories (Meltzer, 2002). In his 2002 essay, Meltzer argued that this trend toward sedentism would have taken some time, as colonization of unknown, unpredictable environments would have encouraged exploration and movement, and, citing work by Kaplan and Hill (1992), Anderson (1995), and Lourandos (1997), made a case for the prevalence of low-density, highly mobile bands that maintained open social networks (for population maintenance). As larger groups developed, they would have sought to minimize their risk (Kelly, 1995), by placing habitats in relatively stable locations with predictable resource availability and familiarity. Over time, however, resource depletion, local environmental change, increases in population density, or a combination of these factors would have “pushed” groups away from these locations, yielding migrations. Better knowledge of resources and technologies (i.e., means of exploiting resources) would have kept populations more stable and more sedentary when environmental conditions allowed.

Thus, the movement of humans would have been a regular occurrence throughout the occupation of the Americas, and not just the first millennia; this has unquestionably been the case for humans globally (after all, the European colonization of the Americas is one of the

greatest mass-migrations known to have occurred, and that was only 500 years ago).

Linguistic, archaeological, and genetic data have all been used to demonstrate both small and large intraregional migrations in the Americas occurring throughout the Holocene (e.g., Lorenz and Smith, 1996; Lewis et al., 2004), as well as local stability and within-region expansion of populations (e.g., Melton et al., 2007). In some cases, however, these data have been used to explore large population movements, four of which are reviewed in this section: the arctic expansion, the origins and expansion of the Na-Dené, the late Plains expansion, and the Uto-Aztecan migration. These four population movements will be specifically significant to the analyses reported in Chapter 6.

The arctic

The arctic, as described in the previous section, was the first region to have been encountered by humans entering the New World. Even though there is no evidence that the first migrants settled extensively in the region, beginning around 12,500 yBP, a few sites appear in south central and northern Alaska, representing more than one tool industry (namely, the Mesa and the Nenana complexes) that are contentiously unrelated (Stanford et al., 2005). By 8000 yBP, humans had additionally colonized the central Aleutian Islands (the Anangula site on Ananiuliak Island, near to Umnak Island in the Fox Island group) and Kodiak Island in southwestern Alaska (Fagan, 2005). Given their location, the immediate question that these sites invoke is whether these earliest settlers represent direct descendants of the initial migrants to the Americas (with the assumption that older sites are submerged or were destroyed by climatic changes), and if peoples living in Alaska today are their descendants. A central line of inquiry that has spawned from these topics asks: who gave

rise to the living populations of the Arctic, and are they, as Greenberg et al. (1986) suggested, a separate migration from the rest of the Americas?

The archaeological relationship of these early Holocene populations with each other and to more recent groups is not resolved (Ousley, 1995). Some researchers (e.g., Ackerman, 1992) contend that the early sites of the Aleutian chain are culturally continuous with others in the Lower Yukon and Kuskokwim River Valleys (i.e., southwestern Alaska), though others (Laughlin et al., 1979) argue for their distinction. There is a hiatus of at least 2500 years between the earliest sites in the Aleutian Islands (the Anangula tradition) and their successor (the Margaret Bay site on neighboring Unalaska Island). The mystery is deepened with the appearance of the Alaskan Small Tool (AST) tradition approximately 5000 yBP, which has been shown archaeologically to have swept from the southern Alaskan mainland both west (toward Point Hope and into the Aleutian Islands), and east to Greenland (Dumond, 1987; 1998). In his papers, Dumond further argued that the advent of the AST tradition represents a complete replacement of previous technologies, and thus the people who produced them. It has been argued as well that, as the AST tradition appears first along coastal regions of Alaska, and is near-ubiquitous across Beringia, it represents an intrusion from Siberia. Archaeologists have demonstrated that this tradition gave rise to the Ipiutak and Norton cultures in western Alaska, and to the Dorset in the Central and Eastern Arctic, but its influence on the Aleutian Islands is not resolved. Two thousand years after the development of the AST tradition, Norton culture peoples in the Bering Sea developed the precursors to what became known as the Thule whaling technology. Approximately a millennium ago, after spreading across Alaska (possibly giving rise to cultures like the Tigara in Point Hope, Alaska), people using the Thule tradition spread eastward, completely

subsuming the Dorset culture that had developed there (and likely coupled with population replacement). Thus, there have been, at minimum, two population replacements in the arctic since 8000 yBP, based on the archaeological evidence, arguing against continuity in the region and possibly for replacement waves from Asia.

Biologists examining anthropometrics and genes have arrived at some interesting conclusions about population relatedness and history in the western arctic of North America, which may clarify the question of who colonized the arctic. Three general hypotheses, which are not mutually exclusive, have been put forth for assessment: the people of the arctic represent isolated populations that survived in refugia (habitable but isolated areas) in the arctic before the end of the Younger Dryas (ca. 10,000 yBP) and then expanded to the west and, over time, eastward (Rogers et al., 1991); the arctic populations represent a limited re-expansion of earlier colonizers from subarctic North America (Rubicz et al., 2003; Schurr, 2004); or a completely separate, later migration from Siberia gave rise to all modern arctic populations (Wallace and Torroni, 1992; Ruhlen, 1998). Stephen Ousley (1995), using anthropometric data collected by Boas, compared data for various North American and Siberian Inuit with the Alutiiq (Aleutian Islanders), concluding that the Inuit of the southwestern coast of Alaska were more similar to the Alutiiq and to some Na-Dené inhabitants of the Pacific Northwest. His results confirm those performed by various other researchers on crania (e.g., Heathcote, 1986; Ossenberrg, 1992), or, by extension, dental studies by Ishida (1993). This makes a case for variation within the arctic, resulting from differential gene flow, founder effects, or, as Ousley contends, “genetic inundation” of the western Alaskan populations from other coastal populations farther south.

In contrast, all mtDNA studies have found extremely limited diversity among arctic groups, who predominantly possess two haplotypes, designated A2 and D2 (part of the A and D haplogroups) (Merriwether et al., 1994; Lorenz and Smith, 1996; Derbeneva et al., 2002). Subarctic groups exhibit more haplotypes (as reviewed above), and do not possess the D2 haplotype (all groups from further south have the D1 type); the D2 haplotype is predominantly found in eastern Asia (Zlojutro et al., 2006). Such limited diversity has led these researchers to conclude that this alone is evidence for isolation, therefore arguing for the refugia model. However, modern populations of these haplotypes are found on both sides of the Bering Strait, but are not found equally among all Aleutian Island inhabitants or Inuit. Indeed, the D2 haplotype is found more exclusively among western (Commander Island) Alutiiq, implying differential gene flow (and therefore cultural influence) from the Inuit living on the Alaskan and Siberian mainland (Starikovskaya et al., 1998; Derbeneva et al., 2002), corroborating an idea put forth by Black (1983). Note, however, that these western Aleutian Islands were settled within the last few centuries, and therefore may reflect a recent incursion from Siberia (Rubicz et al., 2003)²². Further analysis and comparisons of arctic groups with other indigenous groups from North America showed that all arctic groups—Western and Eastern Beringia Inuit, Alutiiq, and Greenland Inuit—possess a unique mtDNA mutation in haplogroup A (Schurr, 2004). Curiously, this has also been found exclusively among all Na-Dené groups, including those inhabiting the U.S. Southwest (Malhi et al., 2001; Zlojutro et al., 2006). Recent research by Hunley and Long (2005) corroborates this

²² In fact, combining Ousley's (1995) and Rubicz et al.'s (2003) results, there is a strong argument that the Alutiiq peoples migrated across the Aleutian chain east to west, further suggesting that the presence of D2 is a result of a recent incursion or gene flow from Siberia. Furthermore, there is no evidence of genetic relatedness to the peoples of Kamchatka, which is geographically close to the Commander Islands, and therefore argues against the west to east movement of the Alutiiq ancestors.

finding, and is used to further suggest that the Na-Dené (discussed in more detail below) are effectively genetically homogeneous with the Inuit and Alutiiq.

The genetic evidence, however, is not straightforward. A great amount of diversity *does* exist among arctic groups and the Na-Dené speakers in the A haplogroup, which indicates a series of small group fissions that link to the multiple population expansions that appear to have originated in modern southeastern Alaska (Saillard et al., 2000). Moreover, there is a distinction between the Inuit and the Na-Dené in the A haplotype that could be used to argue against homogeneity between these two groups (Zlojutro et al., 2006), but does not contradict the conclusion that the Na-Dené emerged from the same source population(s) that gave rise to the Inuit and later accumulated a set of “private” haplotype mutations.

Together, these results present different amounts of support for all three proposed models. First, the earliest inhabitants of Eastern Beringia remained isolated from other populations that continued to migrate south (most likely along the coast). In doing this, they maintained some of the mitochondrial haplogroup diversity of the founding migration(s), while remaining genetically isolated; in this seclusion, these populations commonly developed the A haplotype mutation cited by Schurr (2004) and expanded west, across the Aleutian Islands and eventually back into Siberia, where gene flow resulted in the presence of the D2 and A2 haplotypes on both sides of the Bering Strait. Alternatively, a population from south or west (i.e., along the coast) of the glaciers, in expanding after their recession, brought these unique haplotypes into Alaska. This model would support the skeletal and anthropometric affinities observed by Ousley (1995) and Ossenberg (1992), and could plausibly strengthen the link with the ancestors of the Na-Dené, if the expansion were from the coast of the Pacific Northwest. However, there is no strong evidence to suggest that the

ancestors of the Na-Dené could not have migrated south from Alaska. Either of these models maintain the continuity of the observed haplogroups in arctic populations with those found throughout the Americas. Complete replacement from Asia after the initial migration is not impossible, given the relative genetic homogeneity of the North American arctic populations, assuming Siberian founder populations derived from the same mtDNA haplogroups as those throughout the New World. Were other North American haplogroups (e.g., B or C) found among the modern arctic populations, or among their ancestors, then this last model is less plausible.²³ Overall, however, it is likely that a combination of these models is the best available explanation; ancestral populations might have differentiated in the Americas and also experienced gene flow with Siberian and other East Asian populations. It should be noted that none of these models contradict the demonstrated archaeological replacements: if these haplotypes were fixed among all populations (strongly implied by Lorenz and Smith, 1997), or carried by one of the replacement populations (i.e., the AST tradition or Thule expansion), the same genetic patterns would be observed. Also note that all of these studies suggest genetic continuity between the Inuit and the Alutiiq.

The Na-Dené origins and expansion

The Na-Dené (usually associated with Athabascan speakers) are, collectively, mobile hunter-gatherer populations living on the coast in the Pacific Northwest and on the Western Plateau (from southern Alaska to northeastern California, inland from the coast)—interspersed by linguistically and genetically distinct members of the Salishan linguistic family—and a few agricultural populations found in the U.S. Southwest. They are united by language and, to a lesser extent, culture. Understanding the relationship of the Na-Dené in

²³ Some traces of these other haplogroups may be found in high latitude populations without invalidating the model, if they were the result of recent gene flow from other indigenous populations.

the Northwest to neighboring Salishan-speaking populations is essential in helping to clarify the origins of the Aleut and Inuit. As already noted above, genetic evidence and limited morphological evidence affiliate the Na-Dené with populations living farther north. They are all typified by a fixation of unique mtDNA A-group haplotypes, some of which are shared in common with the eastern Alutiiq and some Inuit (including the A2 haplotype) (Lorenz and Smith, 1997). This is true for both the groups living in the Pacific Northwest and those living in the U.S. Southwest (Malhi et al., 2003; Smith et al., 2005), which supports archaeological and cultural evidence (i.e., oral traditions) that indicate these U.S. Southwest populations—the Navajo and the Apache—are a splinter group that recently migrated from the Northwest.

Questions remain concerning the tribal makeup of the Na-Dené, which were defined initially as a linguistic family separate from those found elsewhere in the Americas (Ruhlen, 1998). As summarized by Campbell (1997, pp. 114-115), the most contentious linguistic relationship is between the Haida (living primarily among the Queen Charlotte Islands of British Columbia) and the other, neighboring Na-Dené (such as the Tlingit to the north), as it is not determined if their linguistic similarities are the result of borrowing or cultural (and therefore genetic) relatedness. Genetic data are equivocal, as many Haida are typified by fixation of the A haplogroup, while also showing signs of gene flow between the Haida and the Salishan-speaking Bella Coola. It cannot be asserted if the differences arose from a Na-Dené ancestry among the Haida with later interbreeding, or an incursion of Salish-speaking people whose interbreeding with Na-Dené and cultural exchange yielded the Haida.

Studies of the Tlingit are directly applicable to resolving this ambiguity. It is interesting that researchers suggest that Tlingit speakers—the most northern Na-Dené group—may be

the result of the hybridization of two sets of languages, one related to Na-Dené and another unidentified language possibly endemic to the Alaskan panhandle before the (purported) expansion of Tlingit ancestors (Krauss and Golla, 1981). Archaeological evidence suggests that a bifacial tool industry was present on the Alaskan panhandle before 7000 yBP, at which time a microblade industry related to those observed in southern Alaska replaced the bifacial points (Carlson, 1996). Curiously, this coincides with the same time period that the earliest Aleutian Island sites were settled. Admittedly, it is not known what language(s) these various toolmakers spoke. Yet, this evidence gives the impression that the Tlingit were migrants from the *north*, which could relate to the original expansion of the Na-Dené and arctic populations. Coupling this evidence with the data available for the Haida, the most parsimonious conclusion is that a north-to-south expansion of peoples from Alaska gave rise to the Na-Dené, and later cultural exchange and gene flow lead to the admixture between the Haida and the Bella Coola.²⁴ Therefore, taking into account this evidence and that discussed for the arctic, a strong case is made for both arctic peoples and the Na-Dené to have originated from Alaska, either as a separate migratory event or after isolation from the peoples who settled the remainder of the Americas. Although there was gene flow in the Pacific Northwest between the Haida and Bella Coola (and, doubtlessly, other groups from different language families), this effectively distinguishes these highest latitude groups from the populations of the rest of the Americas.

The late Plains expansion

In contrast to the ambiguity of origins and movements of populations in the arctic and

²⁴ Note that the relationships among the Salishan-speaking groups, such as the Nootka (Nuu-Chah-Nulth), Kwakiutl (Kwakwaka'wakw), Bella Bella, Bella Coola, and Tsimshian are generally agreed upon, genetically, archaeologically, and linguistically (Malhi et al., 2003). Interestingly, Malhi and colleagues show that these groups had gene flow not just with some Na-Dené, but also with Great Basin and Western Plateau populations.

subarctic, the Caddoan Plains expansion is perhaps the least contentious migration within North America during the Holocene, though it too is somewhat unclear. Both archaeologists and skeletal biologists recognize a discontinuity between two groups in the Northern Plains (the Dakotas); the Pawnee (Central Plains—Kansas and Nebraska) and Arikara (Northern Plains) are craniometrically distinct from the Mandan and Hidatsa (both Northern Plains) (Owsley and Jantz, 1999), and the latter have a longer archaeological record in the region (Key, 1994). Furthermore, there are signs of conflict at the time period in which the Arikara appear in the Missouri River basin, typified by the massacred skeletons found at Crow Creek (Willey and Emerson, 1993). It has generally been agreed that the Arikara represent a recent (ca. 500 yBP) incursion of Pawnee-derived peoples into the Northern Plains, and that the Arikara adopted the Plains Village Horticulturalist/Hunter traditions that were typical of the Mandan and Hidatsa (Blakeslee, 1994; Wescott, 2001).

Yet, there is some contention concerning the origins of the Pawnee, and, ultimately, the Arikara. Both of these groups are members of the Caddoan linguistic grouping, representing a distinct branch of the language family (Campbell, 1997). The Caddo are predominantly located in the lower Mississippi River Valley (Arkansas and Louisiana), as well as western Texas (the Southern Plains), so there is some geographic distinction between the Pawnee and the Caddo. Yet, the archaeological link between the Pawnee and the Caddo is lacking (Scheiber, 2006), though there is a provocative gap in the archaeological record of the Central Plains prior to the appearance of material culture attributable to the Pawnee (Wescott, 2001). It is possible that the Pawnee represent a replacement of previous cultures from the Central Plains, such as the Itskari, given their biological discontinuity, and this archaeological hiatus (Key, 1983; Steinacher and Carlson, 1998). Genetic evidence,

regrettably, has not been examined extensively across the Great Plains to help resolve some of this ambiguity. A study by Bolnick and Smith (2003) did include five modern Pawnee, but conclusions based on such little data are not viable. Even so, the craniometric and archaeological data present a plausible case for a Caddoan migration to the Central Plains and further north within the last millennium, possibly following rivers (e.g., the Mississippi and the Missouri).

The Uto-Aztecan migration

Like the probable southern-to-northern migration of the Caddo, researchers, spurred by linguists, have suggested that humans from central Mexico migrated north into the U.S. Southwest approximately 3500 yBP (e.g., Hill, 2001; Diamond and Bellwood, 2003). Their argument is that the earliest farmers in central Mexico spoke a precursor language to a group of modern languages known collectively as Uto-Aztecan, including many languages found from the northern range of the Great Basin to Nicaragua, including the Pueblo cultures of Arizona and New Mexico²⁵. There is an apparent continuous progression of maize and bean agriculture from central Mexico northward into the U.S. Southwest (Matson, 1999), which coincided with the rise of the Hohokam tradition (Di Peso, 1956; Haury, 1976), potentially composed of peoples speaking variants of both Uto-Aztecan and Yuman (a language family in southern California and Baja California) languages (Shaul and Hill, 1998). Given these clues, in addition to cultural hallmarks of the Hohokam that are found only farther south (ball courts, cremation burials, and intensive irrigation), there is an argument that the advent of agriculture in the U.S. Southwest represents a demic expansion of Mesoamericans speaking Uto-Aztecan languages (Reid and Whittlesey, 1997). The argument against this model is the

²⁵ Of course, this is with the notable exception of the Navajo and Apache who, as previously discussed, were an independent southward migration of Na-Dené occurring during the last millennium.

presence of Yuman-speakers in the region, who did not develop agriculture independently (and instead likely adopted it secondarily), as well as the lack of agricultural subsistence among the most northern Uto-Aztecan speakers in the Great Basin (Hill, 2001). Hill, however, discounted these as immaterial arguments; the presence of the Yuman-speaking groups does not preclude the movement of the Uto-Aztecan peoples (or their cohabitation, suggested for the formation of Hohokam culture), and the populations living in the Great Basin may have abandoned agriculture (much as other modern hunter-gatherers) because of the undesirable climatic conditions in the Great Basin for cultivation.

Some archaeologists continue to argue for population continuity in the U.S. Southwest with the advent of agriculture, but biological evidence convincingly supports the model proposed by Hill. Those disputing a direct Mesoamerican migration interpret the archaeological record as showing an adoption of agriculture, through cultural transmission, by the Yuman-speaking Hakataya (Patyan) and the linguistically isolated (Zuñi-related) Cochise cultures, both of which had deeper archaeological records in the same areas occupied by the Hohokam (Schroeder, 1963; Crown, 1991). Comparing dental crown morphologies, however, Turner (1993) cited discontinuity between the Hohokam and other groups in the region, which he interpreted as evidence of their migratory origin.²⁶ Malhi et al. (2003), citing previous researchers' data, found evidence of male lineage contributions from Mexico in the Zuñi (likely descendants of the Cochise), the Pima (Uto-Aztecan speakers), and the Yuma; this may, in turn, reflect male genetic contributions from Uto-Aztecan migrants beginning at the time of Hohokam cultural formation, or gene flow among

²⁶ However, based on his sample, this could also have been a result of a sudden discontinuity between the occupations of the pre-Classic (before 900 yBP) Hohokam Period and the Classic Period (Fagan, 2005). This change has been interpreted to have been a Mogollon replacement event, likely related to severe droughts occurring in the U.S. Southwest, California, and the northern regions of Mexico (Raab and Larson, 1997).

subsequent cultures in the region as they traded food and culture. Given the presence of haplogroup B among the Na-Dené Navajo and Apache, there is precedence for some intermingling of migrants to the U.S. Southwest with those who were more indigenous to the region.

2.3: “Traditions” of North America: general patterns of subsistence and lifeways

These four examples of migration represent specific examples of a more general pattern of lifeways and interactions that were present in the New World throughout the Holocene. There is evidence for a great amount of diversity in subsistence patterns, changing through time as people developed new technologies and encountered new ecologies. However, even with this great diversity of diets, resource procurement, and cultures, there are broad patterns that define regions in the Americas.

For practical reasons, this section only considers general patterns present in North America north of Mexico. Mesoamerica and South America unquestionably had as great or greater diversity in subsistence patterns and cultures than North America (Gruhn, 2005). A brief examination of this diversity exemplifies some of the general trends found across the Americas. Differences in lifeways among peoples in South America (as well as North America) could exist within circumscribed geographic regions; for example, the tribes of Tierra del Fuego practiced more than one subsistence type: the Ona were terrestrial hunter-gatherers while the Yamana/Yaghan were marine hunter-gatherers (Willey, 1971), but neither used agriculture or is known to have traded with cultivating populations. On a broader geographic range, multiple forms of agriculture developed, including methods cultivating tubers, maize, legumes, squash, and other species. Populations also likely began purposefully to modify their environments early in their inhabitation. For example, recently-

reported evidence has suggested that early hunter-gatherers of the Amazon Basin were involved in shaping their environment by forest clearing, burning, and artificial selection of plant species (Gnecco, 2003), a practice that eventually translated into the construction of complex irrigation systems (Erikson, 2000) and the redirection of rivers (Abizaid, 2005). Thus, complex environmental-cultural interactions defined human occupation in South America (just as they do globally).

Once humans colonized the Americas, archaeological evidence clearly demonstrates a rapid diversification of lifeways and technologies as humans entered new ecological zones and adapted to an ever-changing environment. Patterns of settlement following the initial migration are difficult to merge into a coherent picture of population structure, gene flow, or subsistence prior to 8000 yBP (Fagan, 2005). It is known that multiple lithic industries appeared by 10,500 yBP, some of which had overlapped with Clovis; for example, Goshen and Folsom traditions have been uncovered in North America, fluted bifaces from northern Mexico to northern South America, and various fishtail points in South America (Cooke, 1998; Meltzer, 2002; Lorenzo and Mirambell, 2005). In addition, unlike the presence of exotic materials among the lithic blades of Clovis (though this did not define the majority of Clovis points), these later industries relied more on local sources of rock (Anderson, 1995; Collins and Lohse, 2004). Kelly and Todd (1988) suggested that this represented decreased mobility or less trade among populations, which mirrors the arguments for increased tribalization among early occupants of the Americas, a logical result of multiple low-density human groups occupying the mosaic of new ecologies present south of the receding glaciers. Researchers have long pointed out that this splintering of technologies in the central regions of North America is coincident with the disappearance or substantial decreasing of

megafauna (e.g., mammoths, horses, and large cats) (Martin, 1967), though most evidence suggests that humans merely contributed to the extinction of these large prey species (Grayson, 2006). However, given the apparent diversity of diets among these hunter-gatherers, they had already adapted to a diverse exploitation of resources before the extinction of large prey, including the potential marginal cultivation of plants (Collins, 2006; Dent, 2006; Yesner, 2006) and fishing. In fact, marine fishing was likely common in Peru as early as 10,000 yBP (Reitz, 2001), and it is known that the Spirit Cave male mummy's stomach contents contained the remains of fish and marsh flora (Eiselt, 1997); a bone fishhook was found in Tennessee from circa 9500 yBP (Goldman-Finn and Walker, 1994). Whether these divergent groups remained isolated or interbred, meeting at aggregation sites to exchange information and genes, is still unresolved (Hofman, 1994; Randall and Hollenbach, 2006). It is clear, however, that continued localized adaptations and diversification were common features of the early Holocene in both North and South America.

Populations began to develop settlement patterns at different times and in various patterns among regions, depending on resource availability. For example, by ca. 4000 yBP, people in the Pacific Northwest demonstrate greater sedentism, with more dependence on a regular and more efficient exploitation of regional resources and seasonal movements to enhance this (Stewart and Stewart, 2001). Variable resource scarcity (namely, limited territory) and high population densities likely lead to localized warfare among these populations (Cybulski, 1999). In contrast, wide-ranging foraging behaviors typified life for populations living in the Great Basin, even after the introduction of agriculture (Simms, 1999), given the marginality and unpredictability of the region, with water the most determinant factor of subsistence

behavior and settlement patterns (Schoeninger, 1999). Based on these regional differences in resources and cultures, broad patterns for North American cultural regions may be summarized [all of this information is described in greater detail by Fagan (2005) and the various chapters in Ubelaker (2006)]:

The Arctic: As shown above in the description of migration events, multiple cultures have been typical of the arctic. Nearly all populations, including the Alutiiq, Ipiutak, Dorset, and Thule depended on marine resources—seal, whales, and fish. Inland populations, especially the Ipiutak and the Dorset, may have depended on terrestrial resources, such as caribou, to a greater extent than later populations. It should be noted, however, that Inuit cultures settling farther southeast (e.g., the Kuskowagamiut) equally exploited some seasonal plant species, migratory waterfowl, freshwater fish, and larger terrestrial species. Many of these populations additionally practiced mobile hunting while maintaining annual or seasonal villages.

The Pacific Northwest and Western Plateau: Like their neighbors to the north, many of these cultures depended vitally on the acquisition of fish, shellfish, and other intertidal resources along the coast, and waterfowl, terrestrial mammals, and various small fauna inland. Plants were essential elements of diets as well. A pre-Columbian domestication of plants, however, has never been shown to be present in this region, though the regular collection of certain plant species, coupled with selective burning and pruning, lead to the sustaining of important plant species. As noted above, after an initial period indicating high mobility in the region, by the mid-Holocene populations had largely settled into seasonal or multi-generational villages, though

larger population movements (e.g., the Tsimshian replacement by the Tlingit) are known to have occurred more than once after this time period (Marsden, 2001).

The Great Plains: Defined as ranging from southern Manitoba, Saskatchewan, and Alberta to southern Texas, humans in this region can be categorized into four cultural periods: Paleoindian, Archaic, Woodland, and Plains Village (Wood, 1998). Each of these is typified by different subsistence and settlement patterns. A general trend in the Plains, through all of these periods, however, was the continued exploitation of large migratory herds (namely, *Bison*) as well as fish and small terrestrial fauna, the use of controlled burning to maintain grass species, and aggregations of people along river basins. Later periods were typified by a greater dependence on cultigens and higher sedentism within populations. Middle Woodland (ca. 1000 yBP) sites have yielded tropical cultivates, such as squash, indicating the expansion of trade networks either to the southwest or to the east (Adair, 2006). The presence of some Hopewellian artifacts in the Central Plains additionally demonstrates the presence of trade, and likely gene flow, between the Prairie and the Plains. By the time of the Plains Village cultures, groups generally lived in large villages, where organized horticulture (limited cultivation of plants for small-yield harvesting) and seasonal hunting of bison were regular cultural aspects. Note, however, that highly mobile, hunter-gatherer cultures remained active farther away from the river valleys; this was especially the case for central and southern Texas, where agriculture never occurred over the entirety of the Holocene, and instead a mixture of cultures maintained distinct hunter-gatherer lifestyles—marine hunter-gatherers along the Gulf of Mexico coast and more generalized hunting and foraging populations inland. These

populations were decimated by smallpox after European contact, but probably represent a biological continuity not observed in many other regions of the Americas. Biologically, there is unlikely to have been continuity between the later cultures that inhabited the Central and Northern Plains and the first inhabitants (Jantz and Owsley, 2001). Also, as noted above, during the late Woodland and by the time of the Plains Village cultures, populations from farther southeast (i.e., the Caddo) migrated into the region and replaced or lived alongside populations that had previously settled the region, themselves most likely replacements of the initial late Pleistocene and early Holocene populations that occupied the Plains.

The Prairie and the Eastern Woodlands: Dozens of tribes and highly varied environments are found in the northeastern subarctic regions of North America, but a general cultural pattern links them. Like the Plains, cultural divisions in this region are split into Paleoindian, Archaic, Woodland, and Mississippian periods. One typical practice in this region was the employment of long distance trade networks, moving exotic materials from the edge of the Rocky Mountains, northern and eastern coasts, and various points in between. In contrast to the groups living in the Plains, populations likely had more restricted ranges and maintained centralized settlement patterns from an early period. Before 4500 yBP, populations remained in resource abundant regions while maintaining a limited mobile lifestyle. Some year-round settlements may have existed during the Late Archaic period, though this is still unresolved (Fagan, 2005). Until the end of the late Woodland (ca. 800 yBP), populations of the Northeastern coast mainly exploited wild plants, though some (such as Groundnut) were likely managed plants (Crawford, 2006); these peoples also

focused on terrestrial mammals, small game, fish, and waterfowl, and were generally highly organized territorially. Inland Northeastern groups, as well as Prairie populations from the Ohio and Illinois River Valleys, may have adopted agriculture as early as 2500 yBP, if not before, cultivating myriad crops including maize and squash.²⁷ It is likely that maize, squash and, later, beans were brought to this region via populations to the south and via the long distance trade networks that had already been present. This introduction of agriculture in the Prairie, especially in its western regions, coincided with the expansion of the Adena-Hopewell cultures, which developed large earthen ceremonial and burial structures in addition to irrigation techniques. The Adena-Hopewell cultural complex also represents the coalescence of populations in these regions into organized, hierarchical villages, surrounded by smaller communities. This is a settlement pattern that would—after the collapse of this cultural complex—reemerge as a hallmark of the Mississippian cultures a millennium later (ca., 1000 yBP)²⁸. In the Prairie, two Mississippian chiefdoms would emerge—the Middle Mississippian (including the Mississippi and Illinois River Valleys) and the Fort Ancient culture (centering on the central Ohio River Valley)—that both were distinguished from earlier regional cultures by the higher densities of populations, regional cultural practices and ceremonial centers (e.g., Cahokia), and higher intensity agriculture that placed greater importance on maize and legumes. Although these cultures did not develop the “state-level” social

²⁷ Note that the cultivation and management of local “wild” species, such as goosefoot, sunflower, walnuts, and maygrass had likely started well before the introduction of maize and gourds to the local diet (Crawford, 2006).

²⁸ Cultural continuity between the Hopewell and the Mississippians has not been shown. With the end of the Hopewellian culture circa 1700 yBP, the artifacts that defined what has largely been argued to have been a religion-centric culture cease to be found and the ceremonial structures typifying the Hopewell likewise disappear. However, as populations returned to less centralized, sedentary settlements, they retained the horticultural practices (and expanded into agriculture) and likely maintained the trade networks expanded during the Hopewell period.

hierarchies present in Mesoamerica and South America, they do represent the most hierarchical structured cultures to develop in North America.

The Southeastern U.S.:

Like the neighboring Prairie and Eastern Woodlands to the north, this region is environmentally and ecologically diverse, including temperate woodlands in its northern range, warm coastal margins to the east and south, and subtropical forest to the south. Much of the cultural patterns in the Southeastern U.S. are almost identical to those of the Prairie and Northeast. Like the Prairie, populations before 4500 yBP tended to have greater mobility, though some large cemeteries from the Archaic period (e.g., Windover, Indian Knoll and Eva) are known and have been extensively excavated and analyzed (Doran, 2002; Herrmann, 2002). These sites indicate a wide-ranging hunter-gatherer lifestyle—again with a centralized settlement and foraging pattern—that relied on local plants, gastropods, and the hunting of small- and medium-sized terrestrial prey. They also may indicate that multiple populations were convening and cooperating from early in the Holocene, as Windover and, possibly, Eva were shared burial grounds for more than one population. Although debate over exact timing continues (Fagan, 2005), higher sedentism and greater population density eventually lead to the management and domestication of various plant species, including some gourds and sunflowers, perhaps as early as 4000 yBP in the Ozarks and Texas. These cultigens and horticultural practices eventually spread north and east into the Prairie and Eastern Woodlands, where local forms of squash and other plants were additionally domesticated, developing into a simple agricultural subsistence pattern many decades before the introduction of maize (Fritz, 2006). A

number of populations maintained marine or terrestrial hunter-gatherer lifestyles until many millennia after the development of agriculture, especially those located on the coasts of Georgia and Florida (e.g., Larsen, 1984). Mississippian culture was also extensively present in this region, developing from smaller settlements a millennium ago, extending through most of the Southeastern U.S. except Florida, the eastern coastal margin, and the far south. Indeed, the Middle Mississippian culture found in Illinois extended south into the Tennessee River and lower Ohio River Valleys.

There is little debate that there is some biological continuity within populations in this region, with recent populations likely related to populations inhabiting the region 2000 years ago, but the exact relationship of older cultures to more recent populations is not well-resolved. In addition, evidence from genetics indicate that some of the populations from this region migrated northeast (the Iroquois) or northwest (the Caddo), though these migrations are still debated (Bolnick et al., 2006).²⁹

The U.S. Southwest and Great Basin:

Unlike the eastern half of North America, the U.S. Southwest and the neighboring Great Basin present at least seven distinct major cultures that interacted in complex patterns still being untangled by archaeologists, biologists, and linguists: the Yuma (Patayan), Hohokam, Mogollon (including the Mimbres), Anasazi (and subsequent Pueblo culture), Fremont, Desert Archaic (Great Basin), and Southwestern Archaic (including the Oashara and Cochise Traditions). The Desert Archaic tradition in the Great Basin remained an active subsistence method until the arrival of Europeans,

²⁹ A curious observation that distinguishes the Northeast and the Southeast, made by Bolnick et al. (2006), is the tendency for Southeastern populations to have engaged in patrilocality, while populations in the Northeast tended to engage in matrilocality. This indicates that differences between these regions may be based on fundamentally different biological practices.

and consisted of a succession of different lithic industries that show signs of continuity. They utilized a generally broad exploitation of their environmental resources, employing diverse technologies (including waterfowl decoys, nets, elaborate harpoons, and bows and arrows) to hunt and fish in an environment known for its variable climatic shifts, ruggedness, and aridity. In contrast, the Southwestern Archaic ended by 2000 yBP, at which time many cultures had developed or soon after emerged (e.g., the Mogollon, Hohokam, and Anasazi). Around this time period, the village farming Fremont culture appeared in the peripheries of the Great Basin.

The relationship of these cultures to each other remains a subject of lively debate, though a very broad-brushed pattern, some of which is discussed in greater detail above in the Uto-Aztecan migration section, may be devised (for further commentary, see Reid and Whittlesey, 1997). Generally, the earlier populations of the U.S. Southwest and those of the Great Basin are similar in their broad-spectrum resource exploitation and range of adaptations to marginal environments. Archaic populations in the U.S. Southwest, like their Great Basin neighbors to the north, practiced assorted broad-spectrum hunting and gathering traditions, with regional variation in resource dependence (generally, plants took greater precedence in the wetter western regions). Later time periods in the U.S. Southwest are linked by multiple forms of agriculture and extensive regional trade networks, likely defined both as religious structures and practical roads among settlements (Fagan, 2005). There is evidence that specialized craftspeople in villages developed wares for trade, that in turn were moved along these roads. Agriculture, introduced by trade or brought in by a migration from the Sonora region of Mexico, followed a south-to-north path of

appearance that had likely originated in southern or central Mexico. It is possible that the Mogollon represented a regional continuation of the Cochise and the Hohokam were a mixture of Uto-Aztecan speakers from Mexico and local Archaic populations, while the Anasazi to their north were a mix of local populations. Yuman-speaking peoples (namely, the Patayan) migrated from Baja California into western edges of the region around 1200 yBP (Kaestel and Smith, 2001), adopting a form of floodplain agriculture and establishing trade with the Hohokam and Mogollon peoples. To the north and east, Pueblo peoples (the Anasazi) continued to live in small, affiliated villages (pueblos), and may have been related to some of the diverse populations that are loosely affiliated under the Fremont Tradition (namely, those from southwestern Colorado).

A series of major climatic shifts, occurring in multiple, short periods, caused erratic rainfall in the Southwest. This was especially true to the west of the Continental Divide, where rainfall is less predictable, and populations depended on semi-annual precipitation during both the winter and summer (Dean, 1996). There is evidence that the Mogollon peoples invaded Hohokam territory circa 900 yBP, when the Hohokam culture experienced a massive change before its collapse 200 to 300 years later. These two events coincided with some of these major climatic fluctuations, in addition to signs of increased interpersonal violence in skeletal remains, as well as the fortification of numerous pueblos. It has been concluded that these major climatic shifts would have introduced famine or surplus resources, and so drove population expansion, movements, and warfare (Lekson, 2002; Schimmelman et al., 2003). Droughts occurring around the time of the end of Hohokam culture may

have also spurred the collapse of the Fremont to the north and northwest of the Hohokam. Despite these climate changes, all of the peoples of the U.S. Southwest share the common subsistence pattern of developing complex agriculture in marginal desert environments.

California: California borders the U.S. Southwest, the Great Basin and the Pacific Northwest, and in addition has a long coastal margin alongside deep ocean. For geographical and topographical reasons, Californian peoples developed a wide range of subsistence strategies. Like their neighbors to the north, California peoples demonstrate great amounts of local migration, competition, and tribalization. In fact, of the many languages found in the Americas, California has one of the highest concentrations of unrelated forms (Campbell, 1997), which in turn attests to this variety of cultures and peoples. It is likely that, like the populations in the Great Basin and U.S. Southwest, cultural fissioning and rapid technological development were spurred by numerous, irregular droughts and El Niño events (Schimmelman et al., 2003).

Between the changing climate and the heterogeneous terrain, multiple subsistence methods—most of which were forms of hunting and gathering—developed throughout California. Some peoples, such as those in the San Francisco Bay region and Sacramento River Valley, practiced a complex hunter-gatherer subsistence in which fish, shellfish, and other freshwater aquatic resources were acquired from estuaries and rivers, and combined these with local terrestrial game (such as deer) and a wide variety of plants. In contrast, humans inhabiting the southwestern coast and the Channel Islands depended heavily on marine mammals and limited plant

cultivation (Hildebrandt and Carpenter, 2006), such as members of the genus *Prunus*, while the Yuma, as mentioned above, adopted a form of floodplain agriculture most likely obtained from neighboring cultures to the east and south. Organized agriculture never developed outside of this region of California, though an incipient horticultural subsistence, involving the active maintenance of numerous plant species, was pervasive. Among many of the inland populations, acorns have traditionally been cited as holding significant importance in the diets of Californian populations, who used a number of methods for leeching the nuts and preparing them (Bettinger and Wohlgemuth, 2006) and also practiced widespread controlled burning to aid the seasonal growth of the plant. Researchers suggest that the active harvest of acorns did not begin until more recently, though they were a diet element as early as 6000 yBP (and possibly earlier) (Fagan, 2005). Multiple languages, however, and uncertain relationships among archaeological sites and traditions prevent archaeologists from easily summarizing the broad lifeway patterns of the humans that inhabited California and their interrelationships.

2.4: Complexity as a rule: concluding remarks

One fundamental theme underlies this review of population history in the Americas: great diversity has been shaped by ecological adaptations. Diversity in phenotypes, languages and cultures, as mentioned numerous times above, have been a mainstay in defining the human experience in the New World. There is growing evidence that these differences have been present (though increasing in more recent temporal periods) from very early in the settlement of the Americas. Even though genetics suggest that the amount of *total* mtDNA and Y-chromosome diversity in the Americas is relatively limited (when compared globally), many

of the genetic groups can be traced to the earliest known inhabitants of the continent. In addition, regional studies of genetic variation have started to indicate that multiple large population movements and complex intra- and interregional interactions have become typical over the course of the Holocene. As humans moved across the landscape and settled in distinct environments, possibly bringing different technologies and certainly experiencing fluctuations in climatic stability, their differentiation was controlled by dynamic ecological constraints. Yet many populations also took active roles in altering the local ecologies to support communities of preferred plants, both before and after the development of organized agriculture. Thus, human societies both constructed and were shaped by the environments into which they settled (Stahl, 1996).

Given this latter tenet, how did these phenotypically diverse humans *biologically* respond to changing climates, new environments, various adaptations to and anthropogenic changes to local ecologies? As stated in Chapter 1, this is the central topic of concern in this study. Based on the complex histories of population movements and active alteration of environments, it has been suggested by many that humans were settled in the Americas for too short a period (or did not remain in environments long enough) or practiced too much cultural buffering (via landscape modification, clothing, and food processing technologies) to have been biologically affected by environmental variables, except in very broad patterns. However, previous studies *have* demonstrated that New World human populations often did vary phenotypically with climate³⁰ and with subsistence. These patterns and the concepts that underlie them are discussed in the next chapter.

³⁰ There may even have been a covariance between climate and blood group distributions (O'Rourke et al., 1985).

Chapter 3

OF SEASONS & SUBSISTENCE: HUMAN ADAPTATION & ENVIRONMENTAL FACTORS (BACKGROUND II)

“OF LATE I HAVE BEEN TEMPTED TO LOOK INTO THE PROBLEMS FURNISHED BY NATURE RATHER THAN THOSE MORE SUPERFICIAL ONES FOR WHICH OUR ARTIFICIAL STATE OF SOCIETY IS RESPONSIBLE.”

-Sherlock Holmes, The Final Problem

As established briefly in the introductory chapter, humans, like all other life, vary phenotypically in relation to their environments. This is a fundamental principle in Darwinian evolution (Darwin, 1859). Moreover, variation in phenotypes—molecular, morphological, and physiological—is the keystone to the concept of descent with modification; these characteristics change due to selective pressures, founder effects, drift, and mutation, though only selection is non-stochastic, and therefore is the focus of evolutionary biologists’ attempts to discern adaptation.

Admittedly, it is often difficult to attribute changes in phenotype to selective pressures, let alone term these alterations “adaptations” (Gould and Lewontin, 1979; Lande, 1979; Carson, 1989; Marroig and Cheverud, 2001). This determination is made difficult by the impact of a number of factors. First, multiple selective pressures act simultaneously and interactively on phenotypes (Hamilton, 1961); it is difficult, outside of the laboratory, to isolate a single selection pressure associated with a phenotypic change. Phenotypes also have different levels of restriction in their responsiveness to environmental influences (i.e., canalization) (Waddington, 1942) and the range of variation possible (i.e., developmental constraint) (Maynard-Smith et al., 1985). In fact, there is evidence that organisms may have varying degrees of developmental adaptability in response to environmental influences, which may be genetically fixed over time (i.e., the Baldwin effect or genetic assimilation)

(Baldwin, 1902; Simpson, 1953; Roth, 1982; West-Eberhard, 2003¹). Furthermore, traits that are parts of different functional complexes may be developmentally or genetically linked (e.g., pleiotropy), reducing or confounding their responsiveness to the environment (Wagner and Altenberg, 1996; Lovejoy et al., 2000). Together, these concepts contribute to the amount of phenotypic variability in any given trait. Determining reproductive fitness from these variations, and therefore selective advantage, is often more theoretical or relies on controlled experimentation.

Because they have a wide geographic range and phenotypic diversity, populations of *Homo sapiens* provide the potential opportunity to discern the effects of specific environmental factors on phenotype and elucidate the mechanisms that underlie these influences. Arguably, humans exhibit varying degrees of phenotypic (i.e., developmental) plasticity (e.g., limb bone morphology in relation to mechanical loads) (Ruff, 2005a; Auerbach and Ruff, 2006), in addition to a diversity in traits that likely have been acquired through either outright selective advantage (e.g., Jablonski, 2004) or genetic accommodation (West-Eberhard, 2003; see footnote 1 below). As humans have colonized the globe, the covariation of phenotype with environmental factors may be thought of as a set of “natural experiments” (Ruff, 1994a; Ruff et al., 2005), wherein behavioral and climatic differences have yielded—among other differences, such as skin color—distinct morphologies (body shape, body size, and proportions). By applying broader biological concepts to observed

¹ West-Eberhard (2003) wrote extensively on this concept (see Chapter 6 of her book *Developmental Plasticity and Evolution*), and prefers a concept she terms “genetic accommodation.” This effectively expands the concept of genetic assimilation—wherein favored phenotypic variants, arising from genetic variations, are eventually selected for and fixed in a population (and therefore remove environmental sensitivity in that trait)—to one in which environmental contexts augment or reduce the phenotypic expression of variants, while *not* influencing environmental sensitivity or the amount of genetic determination of a set of traits. In other words, genetic accommodation allows for the preferential expression of certain phenotypes out of a pre-existing variety without increasing developmental constraint. Furthermore, Behera and Nanjundiah (2004) have demonstrated a possible epigenetic model that would allow for genetic accommodation, in which the regulation of structural genes is variable depending on environmental influences.

patterns of variation, researchers have attempted to demonstrate how humans have arrived at this diversity, and the relative roles of the external environment and endogenous factors (e.g., genes). Potentially confounding these, however, is the influence of culture, where behavioral differences and the adoption of “buffering” technologies have likely mitigated some of the effects of other environmental factors, such as climate.

This chapter reviews the evidence for morphological variation in modern humans, specifically in regard to the skeleton and in relation to two general environmental variables: climate and subsistence. It is important to note at the outset that these environmental factors are not independent. Crops may only be grown effectively below certain latitudes and only in the presence of enough moisture, and prey species availability and selection is guided, in part, by climatic factors. Various researchers, reviewed below, regard the influences of these two factors as affecting different aspects of morphology, though the relationships among them have not been resolved.

3.1: An overview of bone biology

The analyses conducted in this dissertation utilize measurements of skeletal elements to reconstruct the shape, size and proportions of the humans to which they belonged. Before discussing the patterns and models of human variation in relation to climatic and subsistence variables, a review of bone biology is beneficial. More detailed reviews are available for bone biology and mechanics (Martin et al., 1998; Currey, 2002; Robling et al., 2006), and additional information is provided in section 4.3 for the reconstruction of human morphologies from skeletal remains (see Chapter 4).

Bone is a dynamic tissue that undergoes constant alteration, repair and replacement throughout life, but many of its final properties are determined by primary growth. The

majority of human skeletal elements form from endochondral bone (wherein a cartilage precursor is replaced by mineralized bone), including almost all of the postcranial bones. Most of the bones of the cranium and a portion of the clavicle are intramembranous bone derivatives (wherein there is no cartilaginous precursor) (Larsen, 2001). Primary growth, structure and architecture of these bones are mediated on a genetic or epigenetic level throughout ontogeny (Hallgrímsson et al., 2002). The development of bone during ontogeny—namely the replacement of cartilage with the addition of new bone, and the deposition and resorption of bone, to attain a final shape and size—is called modeling. The shape and much of the final composition (e.g., peak bone mass) of adult bone is genetically controlled (Marcus, 1996; Martin et al., 1998), although Ruff (2005a) correctly cautions that differences in mechanical loading and skeletal region (which are inherently related), as well as variation in the rates of growth of skeletal elements (resulting from dietary and genetic influences), affect the strength and composition of limb bones at the terminus of primary growth (Prentice, 2001)². In addition, growth factors produced within and adjacent to bone (almost exclusively during modeling) mediate the strength and shape of bone in concert with changes in mechanical loading from body mass, posture and locomotion, and muscle mass (van der Meulen et al., 1993, 1996). Vitamin D₃, parathyroid hormone, estrogens, androgens and their receptors also have profound effects on the development of the mature phenotype of bones (especially modulating the timing of growth cessation), as well as their maintenance after the cessation of primary growth (Smith and Korach, 1996; Devlin, 2004; Vanderschueren et al., 2004). However, evidence exists for regional sensitivity to these

² It is important to note, as well, that bone mineral density demonstrates nothing about bone geometry, which reflects bone adaptation and response to activity and usage (Ruff et al., 2006). Prentice (2001) presents a good summary of the interactions of genetics and diet in determining ontogenetic changes in bone growth, and cautions that an as-of-yet indeterminate variable mixture of genotype (possibly vitamin D receptors) and lifestyle (exercise, diet, and environmental stress) combine to yield adult bone composition.

many factors within the diaphyses of bones (e.g., endosteal versus periosteal envelopes), as well as skeletal regions (articular regions versus diaphyses) (Ruff, 1988; Ruff et al., 1994; Lieberman et al., 2001; Auerbach and Ruff, 2006). For example, long bone diaphyses are more affected by environmental effects, even after the cessation of primary growth, than articular surfaces (Ruff et al., 1991; Ruff et al., 1993; Ruff, 2005b).

Once bones have attained their mature shape and size (i.e., primary growth has terminated), a complex interaction occurs between activity, metabolic stimuli, and multiple intrinsic factors to maintain or alter bone shape. Much research has been focused on the effects of mechanical loading on bone morphology, especially of the diaphyses of limb long bones, for over a century (e.g., Currey, 2002). The principal model used in these analyses is the application of beam theory to bones (see Martin et al., 1998), and its application has been refined and altered as a better understanding of bone architecture and deformation under mechanical loading continues to develop (Lieberman et al., 2004; Ruff et al., 2006). A consistent and fundamental finding throughout this research is that bone senses and reacts to changes in mechanical dynamic loading under strain (not static loading or stress) (Turner, 1998). In fact, bones that have been paralyzed or disused during primary growth maintain a general shape similarity to normal, active bone, but not the specific morphologies (e.g., Murray, 1936), while bone that undergoes disuse after maturity loses strength and cortical thickness (Uthoff and Jaworski, 1978; Forwood and Burr, 1993). The underlying concept is generally termed “bone functional adaptation” (Ruff et al., 2006)³, and further forms the basis of the “mechanostat theory” (Frost, 1987, 1988), in which a sensitivity threshold for bone tissue activates new bone deposition or loss in mature bone (a process termed

³ This term is a retirement of the contested “Wolff’s Law” concept, which has become such a contentious idea because of 1) inconsistent definitions and 2) incorrect interpretations.

“remodeling”) (Martin et al., 1998, pages 260-261; Robling et al., 2006). Note that these same general processes (although not necessarily the cellular activities) exist during growth and development of the skeleton as well (cf. Pearson and Liebermann, 2004). A major distinction between modeling and remodeling is that the latter is initiated by bone removal—osteoclastic activation. The function and controls of this threshold are still being determined through experimentation, and a number of mechanisms to induce bone remodeling, from hydrostatic to chemical pathways, have been proposed (Burr et al., 2002; Robling et al., 2006). Recent experimental models have demonstrated that the responsiveness of bone to increased mechanical loading (e.g., through exercise) has a low threshold and variable periods of responsiveness, in which bone “desensitizes” to the effects of loading over various periods of time depending on loading frequency and intensity (Burr et al., 2002; Turner and Robling, 2004; Robling et al., 2006). This response is a product of mechanical loading, the mechanism(s) that initiate the activity of osteological cells (osteoblasts and osteoclasts), variation in the sensitivity and types of receptors available for the activating mechanisms (which may be regional within a skeletal element), and the metabolism of the organism (e.g., Robling and Turner, 2002; Lee et al., 2003; Ruff et al., 2006). In short, bone responds to environmental influences—especially dynamic mechanical loading—mediated by genetic factors affecting sensitivity and degrees of response.

Some final observations about general tendencies concerning human bone should be noted before engaging in discussion of responses of phenotypes to climate and subsistence. First, articular dimensions, as mentioned above, are less sensitive to the effects of mechanical loading and appear to be under greater genetic control than diaphyseal growth (Ruff et al., 1993). As juvenile humans develop, the size of articulations (namely, those of the lower

limb) do not track with mechanical loadings. However, the final sizes of lower limb articulations match terminal body mass at the end of primary growth (Ruff et al., 1991; Ruff et al., 1994; Ruff, 2007). Because articulations are therefore less responsive to activity patterns—particularly lower limb articular dimensions—they are better predictors of body mass (Ruff, 1990; Auerbach and Ruff, 2004). Second, age-related changes have been noted in the responsiveness of limb bone diaphyses to mechanical factors: namely, in the long bones of older humans (as well as other species), changes in loading activity are accommodated through remodeling the shape of the endosteal envelope, with very little modification of the external dimensions of bones⁴ (Ruff, 1992). Thus, most of the external bone shape in limb bones is reflective of mechanical loading during primary growth and early adulthood (before the mid-twenties). With senescence, bone also increasingly loses density and strength, likely due to a combination of decreasing muscle mass and changes to stimuli sensitivity, as well as lowered hormone levels (especially of estrogen in post-menopausal women) (Burr, 1997).

On a broader temporal scale, as described in multiple examples, robusticity—a measurement of relative strength in limbs—has decreased over time among humans since the beginning of the Holocene, reflecting changes in subsistence and mobility (Ruff et al., 1993). More recent human populations developed more sedentary lifestyles and therefore experienced decreases in lower limb robusticity (Ruff et al., 2006), as well as in humeral robusticity⁵ (Churchill, 1994). Coupled with this trend were overall decreases in body mass (Ruff, 2002a), and decreases in overall amounts of upper limb diaphyseal breadth directional

⁴ There is a tendency for older adults to exhibit very low amounts of subperiosteal expansion of cortical bone (Garn et al., 1967; Heaney et al., 1997).

⁵ Note, though, a greater variation in humeral robusticity occurs in more recent humans (at least from the Late Upper Paleolithic), which in turn indicates that, while overall strength *decreased* in upper limbs, the variety of subsistence activities *increased* (Shackelford, 2007).

bilateral asymmetry (Trinkaus et al., 1994; Auerbach and Ruff, 2006), though the amount of sexual dimorphism in robusticity and in asymmetry has varied in relation to differences in subsistence and divisions of labor (Ruff, 1999; Ruff, 2000b; Auerbach and Ruff, 2006).

Biological anthropologists have argued that lower amounts of sexual dimorphism in a population's limb bone robusticity and asymmetry, however, are associated with fewer task differences between males and females (Collier, 1993; Stock and Pfeiffer, 2004).

On the whole, the development and modification of skeletal elements is complex and still under intense experimental and observational scrutiny. This overview presents only a fraction of the decades of research and controversy concerning the growth, response to environment, and overall trends in human skeletal elements. Two essential points should be taken into account from this section, however: bones *do* react to environmental effects, from intra-organismal effects (such as hormones) to activities (not to mention disease), and so are useful tools with which to understand human adaptation and change in response to environmental effects; differences among human groups in their skeletons reflect a multitude of factors, including genetics (dictating general morphology and responsiveness of bone to environment), subsistence, mobility and climate, but previous research (reviewed in the following pages) demonstrates that not all bones or regions of bones react equally to these various stimuli. Just as diaphyseal breadth and articular dimensions track different aspects of ontogeny (Ruff et al., 1994), different skeletal dimensions demonstrate dissimilar responses to the same stimuli. Thus, phenotypic plasticity varies across the human skeleton.

3.2: Phenotypic responses to climate

3.2.1: General concepts and animal models

This section focuses on the observed phenotypic variation among animals in relation to

climatic factors, with an emphasis on human skeletal variation. All of these studies derive from two thermoregulatory principles developed from publications by Bergmann (1847) and by Allen (1877), both of which were redefined by multiple researchers over the last century, and coined “rules” by Mayr (1956). As originally stated by Bergmann, and translated in James (1970), geographically dispersed polytypic species, or groups of closely-related species, tend to be larger in body size in higher latitudes. Later authors emphasized that this correspondence between morphology and geography represented a “physiological” mechanism: the minimization of the amount of surface area relative to total volume in higher latitude animals reduced the gradient for heat loss. It is debatable if Bergmann intended this mechanism to be an inherent component to the morphological cline (Mayr, 1956; James, 1970). Allen (1877) originally only cited a geographic cline in morphology: the extremities—ears, limbs, tails, snouts, etc.—of animals are reduced in size higher latitudes. Again, later researchers also claimed a thermoregulatory cause for their pattern, wherein shorter extremities in colder climates further reduce the amount of surface area by which heat is dissipated. The converse of these relationships in warm climates was also stated by the original authors. Mayr (1956) termed these morphological trends (though not necessarily the mechanisms behind them) “ecogeographical” patterns.

Numerous authors have argued over the meaning, mechanisms, and interpretation of these “rules.” Rensch (1938) and Mayr (1956) both explicitly redefined these rules as occurring *within species* (or in sister species), and decoupled them from climatic causes. Their arguments were later supported by other researchers (Hamilton, 1961; James, 1968; Holliday, 1995; Blackburn et al., 1999; Meiri and Dayan, 2003). As stated by Hamilton (1961), who was paraphrasing Julian Huxley, “an ecogeographic rule is nothing more than an

empirical observation associating change in character of conspecific populations with that of an environmental factor” (which in this case is geography). This change in the definition of the ecogeographic rules—especially Bergmann’s Rule—was in part a reaction to the vocal objections raised by physiologists (Scholander, 1955, 1956; Irving, 1957; Hensel, 1959), and ecologists (McNab, 1971; Geist, 1987, 1990; Dayan et al., 1991, cf. Ashton et al., 2000; Yom-Tov and Geffen, 2006), who made various claims that competing factors—food abundance, seasonal productivity, species range (e.g., effects of the Rapoport effect as described by Harcourt, 2000), vasoconstriction and vasodilation, pelage, topographic restrictions, and numerous other mitigating variables—were equally important or more influential in the ability of homeothermic species to maintain thermoregulation. Mayr (1956, 1963), Hamilton (1961), and numerous other researchers, though, acknowledged that multiple factors are involved in species adaptation. As Mayr (1956) perceptively wrote (page 107, emphasis added):

The philosophy of “all or none” solutions is exceedingly widespread not only in science but all human affairs. Unfortunately no philosophy could be worse suited for evolutionary studies. All or none solutions are based on typological thinking and alien to the facts of variation. *Multiple solutions for biological needs are the general rule in evolution....* Simple answers are nearly always misleading.

He proceeded to point out that the phenotypes of species are determined as a balance between the local environmental conditions and the “heritage of the species as a whole,” including physiological and developmental mechanisms. Therefore, in general, none of the results reported by the physiologists or ecologists have been inherently incorrect, but their

blanket invalidation of ecogeographic principles on the basis of these other factors is oversimplified.

Part of this discrepancy has occurred because previous researchers have used inconsistent measurements of size (see McNab, 1971, for an example⁶), have used different definitions of Bergmann's or Allen's rules, have examined animals at different taxonomic levels, and have incorporated different climatic variables (if climate is considered at all). A series of papers have called for clarifications in all of these, and standardized methods (Schreider, 1964; James, 1970; Blackburn et al., 1999; Ashton et al., 2000; Meiri and Dayan, 2003). A consensus among most of these authors concerning Bergmann's Rule is that body mass should be the criterion compared within species (or, if among closely-related species, phylogenetic signal must be taken into account), and that the pattern of body mass relative to geography be the tested relationship.

One would assume that length of appendages are still the critical morphological dimension used to assess Allen's Rule, as no explicit revision or comment is made about this ecogeographic rule (Blackburn et al., 1999). If climatic factors are taken into account, then they are examined separately; this effectively argues that the validity of the ecogeographic morphological patterns is not predicated on a relationship between climate and morphology (Meiri and Dayan, 2003; cf. Ashton et al., 2000). Instead, it allows for thermoregulation, pleiotropy, or some other developmental coupling (i.e., other morphologies tied to body mass

⁶ There are numerous problems with McNab's paper. First, he used lengths as a proxy for body size among species, though this would have to assume isometry in body shape among all of the mammals he was studying to be applicable. Allen's Rule, in fact, predicts a *lack* of isometry in body proportions across geography. Second, he did not use the same measurements of length among the organisms he observed, but did exclude tails. Third, he mixed mean values and individual values in the same comparisons. Fourth, he divided his species comparisons into arbitrary latitudinal groups rather than just compare species across their total geographic range. These four problems alone call into question any results that McNab produced. Additional oversights, such as the lack of reporting sample sizes or the mixture of combined sex data with sex-specific data, nullify any argument McNab made, even if some of them could have been valid. Note that Ashton et al. (2000) effectively invalidated his study as well.

or extremity length are the targets of selection), or ecology (resource availability and acquisition, or resistance to starvation) to be equal possibilities for mechanisms influencing the ecogeographic patterns (e.g., see Ashton, 2002). My inclination, however, is to maintain the rules as originally conceived by Bergmann and Allen, in that thermoregulation is an essential mechanism by which to explain the variation in relation to geography (see Ashton et al., 2000, for the argument for keeping temperature regulation part of the definition, but compare with Ashton, 2002).

Does the evidence for Bergmann's Rule and Allen's Rule among non-human animals support these ecogeographic models? In his dissertation, Holliday (1995, pages 44 to 49), as also noted by Pearson (1997), presented an informative summary of studies examining variation among homeothermic species (namely birds) in relation to latitude and climatic variables. Holliday notes that these studies provide strong support for the ecogeographic rules (e.g., Snow, 1954; Hamilton, 1961; James, 1970; Johnston and Selander, 1973; Luria et al., 1981; Stevenson, 1986; Yom-Tov and Nix, 1986; Klein and Scott, 1989; Aldrich and James, 1991; Graves, 1991)⁷; in all of these studies, the animals under consideration exhibit larger body sizes (lengths or body masses) in locations with colder climates or in higher latitudes. A few of these studies examine Allen's rule as well and note shorter extremities (e.g., ears and feet in *Lepus*) among animals in colder climates and higher latitudes. Likewise, Holliday argued that the possibility that other mechanisms (such as those proposed by physiologists) relate to the geographical patterns do not invalidate the empirical findings from examining species size variation alone in relation to geography. As Ruff (1994a) stated, those mechanisms "are *additive* rather than *exclusive*" (emphasis in original).

⁷ Note that some of these studies were not cited by Holliday.

Although there are occasional exceptions (e.g., Yom-Tov et al., 2002⁸), a majority of analyses have supported the existence of morphological patterns that match the expectations of Bergmann's and Allen's rules, using or excluding a definition tied to a thermoregulatory mechanism (Ashton et al., 2000).

In addition, from the studies reviewed by Holliday (and some in the decade since Holliday's dissertation), have made a few interesting refinements to the general concepts as originally envisioned by Bergmann and Allen. Multiple researchers examining non-human animal species (Hamilton, 1961; James, 1970; Murphy, 1985; Root, 1988; Ashton et al., 2000) have arrived at the same conclusion: temperature extremes, and not overall climate, are most likely creating the selection pressures that dictate variation in body size and extremity length. Furthermore, the amount of ambient moisture creates an additional gradient, as heat dissipation may be more difficult in humid environments: assuming that the ability for bodies to dissipate heat through evaporation is the most important factor in warm environments, body size may be reduced in warm, humid climates, compared with warm, dry climates. This pattern would exist in an attempt to decrease heat production, which scales positively with body mass (Smith et al. 1995). Thus, in more recent studies examining ecogeographical patterns with thermoregulation as a component of the definition, researchers examining non-primate species include multiple climatic factors in their studies (and not just mean annual temperature), and cite the great importance of ambient moisture in influencing body size (James, 1970; Aldrich and James, 1991; Yom-Tov and Geffen, 2006). In addition, Meiri and Dayan (2003) demonstrated that seasonal migration among species—long debated as a

⁸ This study, however, is inconclusive, as its authors only examined a bird species within the limited geographic range of Israel and the Sinai Peninsula. Although Yom-Tov et al. claim that there is great climatic variation in this circumscribed region, they never report the climatic ranges. In such extreme desert regions, as well, species may be adapting to a number of selective pressures. Moreover, even though deserts are cold at night, they hardly match the temperature extremes found in the arctic!

confounding factor in studies, especially of birds—does affect their conformity to Bergmann’s Rule. Birds that migrate away from locations with cold winters to more temperate locations fail to demonstrate the clines observed among non-migratory species. This emphasizes the importance of climatic *extremes* as a selection pressure on morphology.

One important point of clarification should be made that none of these non-human studies have introduced. Bergmann (1847) explicitly stated that the ratio of surface area to overall volume of an animal will vary in relation to heat conservation. Ruff (1991) made a crucial point regarding this ratio in regard to humans, but it is generally applicable to all mammals: geometrically modeling the core bodies (i.e., thorax and abdomen) of animals as cylinders, the controlling factor in relative surface area is the diameter of the cylinder. Mathematically, in a cylindrical solid, length cancels out as a factor in the ratio of surface area (πDL , where D is diameter and L is length) to mass, or volume ($1/4\pi D^2L$). (See Figure 2 in Ruff’s 1991 paper for a visual representation of this relationship.) Yet, all of the studies of non-human species cited above have focused on body lengths or body mass as a proxy for this ratio. Clearly, body length is a poor choice for examining the effects of thermoregulation and Bergmann’s Rule. Use of body mass may be more justified, based on the assumption that larger animals will have greater mass relative to surface areas. Although this may be generally true, it is an errant assumption, as two animals of equal mass could have different core body widths. Therefore, were they to incorporate this geometric model, the results of previous studies on non-human species may more robustly support the relationship between ecogeographic clines in body size and thermoregulation.

3.2.2: Body morphology among humans

As a widely dispersed species, occupying a range of environments from the tropics to the

arctic, in deserts, rainforests, and all environments in between, humans provide a unique opportunity to observe the effects of climate on morphology. It is arguable that technology and artificial buffers against climatic extremes (especially in climatically cold regions) have allowed for this great geographic range of habitation (Newman, 1956, 1970; Crognier, 1981), which will be addressed further below. However, even with this potential cultural buffering, humans across the Earth exhibit morphological variation that supports the predictions of Bergmann and Allen.

Global Samples and the Old World

The majority of studies concerning human morphological adaptation to climatic factors have focused on populations living in the Old World, namely Europe and Africa. These can be divided into studies that consider the crania or postcrania, as both, interestingly, have rarely been examined concurrently in the same samples, mostly by anthropometric researchers: Newman (1953), Stegmann (1972), and Hiernaux and Froment (1976), and Crognier (1981). Furthermore, some studies have focused on archaeological human samples and fossil hominins (especially Neandertals), while others have discussed variation among living humans, though often evidence from the latter is used to support observations made about the former.

Studies of cranial variation among living and archaeological humans have principally examined three morphologies: shape of the neurocranium, size of the cranium, and dimensions of the nasal aperture. A foundation in this research—particularly the first two aspects of morphology—was pioneered by Kenneth Beals and colleagues (Beals, 1972; Beals et al., 1983; Beals et al., 1984; Reinbold et al., 1985). Four principal results were reported in these studies: human crania have a tendency toward brachycephaly (“round-headedness”) in

cool, dry environments, and dolichocephaly (“long-headedness”) in warm, dry environments; crania among populations in cooler and drier climates also have a tendency to be larger than those of populations in warm climates; variation in cranial proportions is driven more by changes in cranial breadth than they are by length; and humans exhibit an ongoing, overall trend toward brachycephaly in more recent time periods⁹. Their results were based on regional means, and so obscure a number of interesting exceptions that they do note. For instance, the Inuit and (to a lesser extreme) inhabitants of Tierra del Fuego have more dolichocephalic crania than Beals had suggested would have been predicted for their cold environments, though other authors have suggested that this discrepancy is the result of masticatory stress (Hylander, 1977; Hernández et al., 1997). It is noteworthy that Guglielmino-Matessi et al. (1979), using Howell’s (1973) craniometric data for individual populations, also demonstrate the same trends between climate and cranial shape, and cite a significant negative relationship between vault breadth and temperature, which also has a positive relationship with facial height and prognathism, as well as a positive correlation between humidity and maximum cranial vault length.

Beals et al. (1984) also noted that the relationship of cranial size to latitude has a higher regression slope in the Old World than the New World (tentatively supported by Harvati and Weaver, 2006). Criticisms of this paper by respondents caution, however, that the correlation of climates with the variation in cranial shape and size is not necessarily causative, and that cranial shape is affected by a number of contributory factors, including birth canal restrictions, masticatory stress, brain development, and overall scaling relative to body mass (see comments by Girgis and Turkel, Gibson, and Trinkaus published with Beals

⁹ Note that Beals et al. (1983), in examining the crania of Neandertals and Early Modern Humans, found that Neandertals had relatively rounder crania, and also exhibited considerable variation between Neandertal skeletons from Europe and those in the Near East.

et al., 1984). It is significant to note, for instance, that the trend toward brachycephalization in more recent modern human populations has been coupled with a decrease in the size of teeth and a reduction in masticatory stress, possibly in concert with the advent of agriculture (Carlson, 1976; Sardi et al., 2006). Yet, as argued by Lahr and Wright (1996), cranial *length* varies more in relation to cranial robusticity (which is not considered in this study), and in turn with mastication; their conclusion was that individuals with longer crania had experienced tougher diets. Furthermore, as summarized by Kouchi (2000), the causes for secular change in head shape (trending toward brachycephalization) are unresolved. For example, a rapid trend toward round-headedness among the Japanese in the last millennium (Nakahashi, 1987; Hossain et al., 2005) has effectively stopped in the last thirty years (Kouchi, 2000; Hossain et al., 2005). Here the correlation with external factors is ambiguous, though likely multifactorial (e.g., mastication, scaling with changes in stature, and climate).

In the facial skeleton, most research has found a significant connection between nasal aperture shape and climate. A number of studies have demonstrated that nasal aperture width, relative to height, is lower in populations that inhabit cooler, drier climates (Thomson and Buxton, 1923; Hiernaux, 1968; Crognier, 1981; Carey and Steegmann, 1981; Franciscus and Long, 1991). More recent authors (Carey and Steegmann, 1981; Franciscus and Long, 1991; Hall, 2002) have argued that the narrowing of the nose is related to the physiological ability of the nose to condition air, both adding moisture and warmth on inhalation and preserving the same on exhalation. This assumes that nasal external apertures reflect internal nasal architecture, though this relationship is not clear (Churchill et al., 2004). Additionally, some authors have claimed that nasal aperture shape is driven by overall changes in the face

arising during ontogeny (St. Hoyme and Iscan, 1989), possibly in relation to other environmental factors (e.g., mastication, as well as climate, on relative facial breadth). Authors have called into question the relationship between facial breadth relative to facial height and climate (e.g., Steegmann, 1970) however, and have proceeded to point out that at least some variation in facial measurements is related to changes in nasal shape (Harvati and Weaver, 2006). Despite these uncertainties, the empirical pattern remains in relative nasal aperture dimensions, though Harvati and Weaver (2006) found that, by removing high latitude samples from their study, the significance of the relationship between climate and nasal aperture dimensions lost significance¹⁰.

One final, crucial point concerning crania is the observation that cranial and facial shape is most likely reflective of population history. That is, selective pressures from climatic influences, as implicated by Harvati and Weaver (2006), may only exert a significant effect among groups living in extreme temperatures. As Roseman (2004) showed by a correspondence of microsatellite variation with cranial form—therefore implying that population history and not individual adaptation to environmental factors—this decoupling of cranial shape with environment has further support. However, it does not preclude the possibility that the population history effects on cranial shape were not themselves influenced by selective environmental pressures.

Far more studies have been conducted on the relationship of postcranial morphology in relation to latitude and to climatic factors. Coon (1955) anecdotally noted that humans in different environments vary in shape and limb lengths, reflecting more specific results reported previously in surveys of human variation by Schreider (1950) on relative surface

¹⁰ The removal of the high latitude sample from their study also removed the extreme cold and low moisture climate from their analysis, so the difference in results is equivocal.

area/body mass among Old World populations, by Roberts (1953) on body mass in multiple global populations, and by Newman (1953) on a variety of morphologies—both cranial and postcranial—in a survey of the Americas. A discussion of the results of the last paper is deferred to the summary of findings from New World studies below. The first two papers, however, generally demonstrated that populations in more tropical regions are absolutely smaller in body mass, have more surface area relative to body mass (though Schreider's calculation of surface area using the DuBois formula may be inaccurate and tautological, as it is calculated using a power of body mass). These original observations arguably initiated fifty years of ongoing (though not constant) research into relationship of climate with human morphological variation, spurred in part, as Ruff (1994a) argued,¹¹ by an increase in zoological studies reflecting the presence of ecogeographic trends in various species.

In this half century of research, most published studies until 1980 utilized anthropometric measurements of living populations to ascertain the role of ecogeographic patterns in morphological variation. These added resolution to the kinds of morphologies varying among human groups, and the specific morphological patterns in relation to climatic factors, generally supporting their correspondence. In examining the ratio of weight to stature, as well as these two measurements individually, researchers demonstrated that tropical populations have low weight relative to surface area (Newman and Munro, 1955; Garn, 1958; Schreider, 1964; Hiernaux et al., 1975; Roberts, 1978). Newman and Munro (1955) examined “U.S. white” young (19-20 year old) males in their study, and found significant, negative relationships between weight and surface area with mean annual, July, and January temperatures, but found no relationship with stature. This is significant, as it demonstrated

¹¹ In fact, Ruff provided a comprehensive historical perspective to the development of the study of human morphological variation in relation to climate and geography in this 1994 review paper.

that rapid morphological change over a limited number of generations or developmental plasticity in weight or relative surface area (though crudely calculated) might be present among males of European descent. More importantly, it argued against the relationship of total stature with climate (or a third factor in common with climate), and therefore likely disputes the conclusion of Newman and Munro (1955) that cold climates increase food intake and therefore resulted in higher weights. Schreider (1964), furthermore, demonstrated that two trends could lead to these patterns of weight/surface area variation: individuals could have smaller body dimensions altogether (isometric decrease), or have redistributed weight with relatively longer (in warm climates) or shorter (in cool climates) limbs relative to trunk length. Roberts (1978), using the widest sampling of human populations to date, demonstrated this directly, showing that relative sitting height (the height from the base of the spine to the crown of the head relative to total stature) is lower among populations living in locations with higher mean annual temperatures, and that relative arm span (total length of outstretched arms relative to total stature) is greater¹². Therefore, lower weight/surface area ratios in tropical populations are likely a composite of relatively longer limbs and narrower bodies. As stature did not correspond with climatic factors, then the only other morphometric means to decrease body mass would be to have lower body breadth.

Indeed, body breadth—the essential component in the cylindrical model developed by Ruff (1991)—was introduced into anthropometric studies by Hiernaux and Froment (1976), who demonstrated in sub-Saharan African samples that: 1) populations in drier climates are narrower in bi-iliac (pelvic) breadth (and vice versa), but *wider* in bi-acromial (shoulder)

¹² Roberts (1978) fully admits that relative arm span is a poor morphological assessment of the relative length of the upper limb, as it incorporates both total upper limb length *and* shoulder breadth, which likely vary independently in relation to environmental factors. Indeed, Hiernaux and Froment (1976) demonstrated this explicitly, finding bi-acromial (shoulder) breadth is higher among populations living in wetter environments.

breadth, and 2) populations from warmer and drier climates tend to be taller (*contra* Newman and Munro, 1955). Interestingly, Hiernaux and Froment also demonstrated absolutely wider nose breadths and absolutely wider faces in more humid climates. A decade later, Hiernaux (1985) expanded his sample to include Europeans, and showed that populations from the lower latitudes have absolutely narrower bi-iliac breadths and relatively wider shoulders (relative to bi-iliac breadth) than those populations from higher latitudes. Importantly, these shape differences do not change in undernourished populations, whereas stature does. Building on these results, Crognier (1981) indicated different potential climatic sensitivities in morphologies among Europeans, namely that (as shown by previous studies) cranial breadth is wider in colder and wetter climates, that nasal height and breadth are inversely related to temperature and precipitation (i.e., heights are greater in colder and drier climates while breadths are lower), and that bi-iliac breadth and total stature are related to temperature (warm month temperatures for stature, cold month for bi-iliac breadth), and precipitation (bi-iliac breadth only, wider in wetter environments).

More recent anthropometric studies have continued to expand the list of morphological correlates with climate and geography, though those published in the last decade have demonstrated muted relationships compared with the earlier surveys. In addition to his discussion of relative sitting height and body mass, Roberts (1978) also confirmed Hiernaux's results for bi-iliac breadth in relation to mean annual temperature, and found that relative forearm length (to upper limb length) is higher among populations found in warmer climates, and determining that chest girth and absolute sitting height (i.e., upper body length) are higher in populations living in colder climates. Many of Roberts' findings were corroborated in more recent samples by Katzmarzyk and Leonard (1998), though they

described the trends as less robust, especially for body mass. They attributed this finding to more cultural buffering and possible confounding by nutrition. In fact, Steegmann (2005), revisiting the study by Newman and Munro (1955) using more recent data (gathered in 1988), found that only proportional differences related to ancestry (i.e., U.S. “whites” versus “blacks”) distinguished his samples, and that variation in relation to geography had ceased to be significant (or even observed). His results argue that differences in relative upper and lower limb lengths in these groups are the result of genetic fixation for these morphologies, and are not affected by climate during growth (or that cultural buffering and higher migration rates among modern populations remove their effect).

Interest in the relationship of morphology to climate among the skeletal remains of archaeological humans and fossil hominins increased with the publication of Erik Trinkaus’ (1981) chapter on Neandertal limb proportions.¹³ In this paper, he reported that not only absolute limb length, but the proportion of distal to proximal elements in limbs vary in relation to temperature. Shorter distal elements (i.e., radii and tibiae), relative to proximal elements (i.e., humeri and femora)—that is, smaller brachial and crural intralimb indices—are found in modern human populations from colder climates and European Neandertals. This was an idea originally propagated by various researchers, though it is often attributed to Coon (1962). In a series of works by Ruff (Ruff 1991; Ruff and Walker, 1993; Ruff, 1994a; Ruff, 2002a), Jacobs (1983; 1985; 1993), Franciscus (1989), Churchill (1994), Holliday (Holliday and Trinkaus, 1991; Holliday and Falsetti, 1995; Holliday, 1995; Holliday, 1997a; Holliday, 1997b; Holliday, 1999; Holliday and Ruff, 2001; and Holliday, 2002), and Pearson (1997, 2000), among a number of other authors, many of the patterns reported in

¹³ It is important to note that most, if not all of these studies of Old World variation, have incorporated archaeological samples from some New World populations. These have mostly been from the high arctic (e.g., Greenland Inuit) or, occasionally, the U.S. Southwest.

anthropometric studies have been reestablished. Humans from lower latitudes (and fossil hominins from Africa) have relatively longer limbs (compared with torso height), lower body masses [estimated from femoral heads or a morphometric method described by Ruff (Ruff et al., 1997; Auerbach and Ruff, 2004)], and absolutely narrower bi-iliac breadths. Perhaps the most important implication of these authors' research is that living morphological characteristics of the human body may be estimated from skeletal measurements and careful modeling.

As mentioned, another component to this research—the cylindrical model for human shape—was added by Ruff (1991) to aid in the modeling of the human body and understanding the morphological significance of the surface area/weight patterns widely reported by previous authors. Ruff (1991, 1994a) revealed that absolute body breadth decreases with latitude among skeletal samples from the Old World. Under the cylindrical model, this would translate into higher surface area relative to volume in tropical populations, regardless of their statures.

Numerous other morphological observations were added by these researchers examining skeletal remains. Most of the authors who have examined the brachial and crural indices have observed that there is sexual dimorphism in brachial indices (females universally have lower brachial indices than males in the same population), but not in crural indices (e.g., Trinkaus, 1981; Ruff, 1994a). Trinkaus (1981), in addition to demonstrating the climatic relationship with brachial and crural indices, also implied that the (then provisionally) cold-adapted European Neandertals had broader thoraxes (on the basis of long clavicles relative to humeral length). This was supported by Churchill (1994). More importantly, Trinkaus also showed that the early modern human migrants to Europe had high brachial and crural

indices, an observation corroborated and expanded by Holliday (1995; 1997a,b). One of the most lasting (and pervasive) conclusions of their research has been that the change in limb proportions takes place over many ontogenies (i.e., many generations), taking as long as 10,000 years in Europe as modern humans migrated from Africa and the Near East. A curious implication of Trinkaus' (1981) results (though not mentioned by Trinkaus) is that there is a scaling effect in the limbs. That is, distal elements are disproportionately longer relative to proximal elements with increased limb length. This apparent scaling was rejected by Holliday (1995, 1997a), but he did note that femoral head size exhibits positive allometry with body mass, and humeral length scales negatively with increasing body size (in his research, the geometric mean of all measurements). Note, however, that Holliday and Ruff (2001) demonstrated that more of the variance in intralimb indices is contributed by the distal segments, and that males have unequal amounts of variance in the distal elements (tibiae have greater variance than radii). They also corroborated the negative scaling of humeral length in males with size, and additionally reversed Holliday's previous rejection of positive allometry in the tibia (found to be significant in both sexes). Holliday (1997a) also noted that "limb/trunk proportions more effectively segregate out individuals from broad regional groups of recent humans than do either brachial or crural indices." Thus, one would expect ecogeographic patterns to be strongest not in intralimb indices, but in the relative length of the upper limb and of the lower limb to torso height.

New World

As noted in the Introduction, research on morphological variation in the Americas in relation to climate, in contrast to these many studies in the Old World, has been generally lacking. As mentioned previously, I posit that this is the result of three factors:

- a general belief that the populations of the New World exhibit lower amounts of variation (as quotes from the Introduction demonstrate) and therefore have not adapted as obviously to environmental factors
- a focus of research on the Old World because of its ties to modern human origins and the debate over Neandertal affinities with modern human populations
- effective difficulty (or perceived difficulty) in obtaining access to the skeletal remains of New World populations because of protection and repatriation laws (e.g., the Native American Graves Protection and Repatriation Act)

However, the few studies that have been conducted present a sketch of morphological variation in the Americas, and demonstrate that variation in body size, shape and proportions in the New World is not as restricted as believed.

Marshall Newman instigated research focusing exclusively on the Americas. His 1953 paper was among the first to attempt a more comprehensive, focused New World ecogeographic variation study, in which he used isolated (and sometimes very small) samples to develop coarse isoclines for select anthropometrics. He showed that high latitude populations appear to have had long torsos relative to statures (and so, had relatively short lower limbs), as well as generally larger crania, higher upper facial indices (i.e., wider faces), and lower nasal indices. Stature, as expected based on Old World studies, was not reported to correspond significantly with latitude, though Newman was one of the first researchers to note that the tallest individuals in the New World are located in the Great Plains and eastern United States. In his follow-up study (1960), Newman implied that there is considerable variation among populations from the arctic, and that previous studies that had used Inuit

samples had used a biased sample of less massive populations (e.g., Newman and Munro, 1955). He additionally demonstrated that body mass increases with latitude and coldest month temperatures, though there are notable exceptions (such as populations in the U.S. Southwest) which likely reflect the recent increase in obesity among some indigenous populations in the Americas with the introduction of European diets¹⁴.

Johnston and Schell's 1979 anthropometric study expanded on Newman's initial efforts, though their primary interest was in anthropometric variation rather than climatic or specific geographic (e.g., latitudinal) effects. Their sample was North American-biased; only selected South American groups from northwestern and central portions of the continent were employed. Overall, their data corroborated Newman, in that populations from higher latitudes are more massive. The tallest individuals were again located in the Great Plains, but samples from the Northwest Coast were likewise tall; statures were lowest among samples from Mesoamerica. Although limited, their body breadth data indicate a slight trend for lower latitude samples to have narrower bi-iliac breadths, though no clear pattern is reported for shoulder breadth. The former finding was expounded upon by Ruff (1994a), who noted that pelvic breadths in the New World generally do not exhibit the range found in the Old World. He attributes this to "cold filtering," in which migrants to the New World were adapted to the climates of higher latitudes, and their morphologies continue to adapt to the various warmer climates encountered when they settled in the Americas. An unexpected result indicated by Johnston and Schell (Table 12.4) was that all of the Mesoamerican and

¹⁴ A few researchers (e.g., Bindon and Baker, 1997; Little and Steegmann, 2006) have cited Neal's (1962) "thrifty genotype" as an explanation for this occurrence. Under this model, populations that had lived in marginal environments and therefore experienced reduced caloric intake would have adapted to storing much of their food intake as fat. When these populations have been exposed in recent decades to a greater and more regular caloric supply, their bodies continue to store more of this as fat despite the lack of selective advantages for this.

two South American groups meet or exceeded the Inuit in having relatively short legs. Notably, some of these lower latitude populations (the Maya and Otomi) were from subtropical regions with high humidity as well as high temperatures.

Sara Stinson vastly improved on these previous studies in her 1990 paper. Her sample—anthropometrics obtained from 62 South American groups—has been the largest and most representative used to date. Like previous studies, she demonstrated a relationship between relative sitting height and temperature: both males and females in populations from locations with lower temperatures (significantly in the case of mean warmest month temperature for females) and drier climates (significantly for both sexes) exhibit relatively shorter lower limbs, as well as absolutely shorter torsos. Her data did not support a temperature correlation with stature, but did indicate that taller statures occur in drier climates. Stinson instead attributed the differences in stature to nutritional or socioeconomic differences that, in turn, might be associated with precipitation. Interestingly, Stinson noted a lack of correspondence between genetic variation and morphological variation, and concluded that body proportions are likely the result of simple polygenic traits. This may have been a premature assessment; without better knowledge of the mechanisms controlling body growth and development, especially those controlling limb proportions, any assumptions about the amount of genetic plasticity in these traits is reduced to conjecture. Nevertheless, it is an interesting idea.

Marshall Newman, then, in his three papers, succeeded in developing a testable model of New World variation, and Johnston and Schell, followed by Stinson, attempted to further develop this. However, as the majority of researchers have, they relied on published sample means taken from living populations (with the notable exception of the skeletal craniometrics published in the 1953 Newman paper). Using results calculated from incongruent mean data,

obtained by various researchers using different methods, is prone to unaccountable error. Given their availability and the lack of published skeletal data, the anthropometrics from ethnographic studies provided a logical solution by which to investigate ecogeographic trends. Yet, as Newman cited in his 1953 and 1960 papers, the data represent populations that were recently “interbred” with European-descent populations, that might have migrated recently (possibly before European contact), and that could have been physically altered by shifting resources, socioeconomics, and nutrition. None of these papers incorporated direct measures of limbs or their proportions, due to the simple problem that anthropologists historically did not measure them. Even with these data shortcomings, these authors still found the broad clines outlined in these papers.

Using the Boas anthropometric data from the Columbian Exposition, Jantz (Jantz et al., 1992; Jantz, 1995; Jantz, 2006; Jantz et al., 2007) addressed many of these problems. The Boas data are more geographically representative of North America, include limb measurements, were obtained from a majority of “full-blood” individuals, and were taken using a strict, consistent methodology (see Jantz, 1995, 2006 for comprehensive descriptions of the data). His analyses generally presented a stronger relationship between morphology and geographic variables, as well as warmest month mean temperature. Again, as found by Newman and Johnston and Schell, populations from the eastern and Plains regions of North America are generally taller (as are populations in climates with warmer summers). Also corroborating these previous studies, cormic indices (lower limb length relative to sitting height) are lower among groups from the northwestern regions of Boas’ sample data, as well as in locations with colder summer temperatures. This trend is also found in the relative length of the upper limb to the torso, though not as robustly. Interestingly, Jantz et al. (2007)

also reported wider upper bodies in *warmer* climates, *contra* Roberts (1978) and studies of upper body breadth in the Old World (e.g., Churchill, 1994). Importantly, it should be noted that Jantz et al. (2007), in comparing cormic indices, demonstrated a wider range of variation in North America than has been observed in the Old World. This is the first study to suggest that New World variation in morphological traits could exceed that observed in the Old World.

More regional analyses have been conducted in North America as well. Hall and Hall (1995), using anthropometric data, argued for ecogeographic patterning in the Pacific Northwest, citing longer lower limbs in drier and warmer climates as well as lower nasal indices (relatively narrower nasal apertures) in cooler, drier climates. This result was corroborated by a survey of populations from various locations across the globe by Hall et al. (2004). An interesting geographical pattern was also noted by Hall and Hall (1995) concerning stature, lower limb length, bi-acromial width, and absolute head length, wherein these morphologies increase north of 50° latitude, but also increase *south* of 50° latitude, though stature and absolute head length have been shown to have little relationship with climatic variables by previous research. Also, using Ruff's cylindrical model, Lazenby and Smashnuk (1999) demonstrated that second metacarpals among the Sadlermiut had low surface area-to-volume ratios, and therefore conformed to Allen's Rule.

Karen Weinstein (2001, 2005, 2007), in examining skeletons from the Andean region of South America, additionally examined variation in thorax size and intralimb indices in relation to altitude. Her research indicated humans living above 3500 meters in the Peruvian and Chilean Andes have body proportions similar to those found among Inuit: low intralimb indices and high torso girths. These results support Stinson's (1990) conclusion that the cold,

dry climate of the high altitude regions of South America have similar effects on morphology as the high latitude circumpolar regions. Weinstein (2001, 2005), however, cautioned that the wide bodies of samples from 2500 meters and above also likely are affected by adjustments to hypoxia, especially as these individuals (above 2500 meters but below 3500 meters) did not significantly differ in intralimb indices with those samples from lower altitudes.

A final point, raised by Jantz (2006) and worth further consideration is an apparent positive allometry observed in the lower limb among individuals with greater statures. This is an alternative explanation he offers to the observed trend for relative sitting height to be higher in the populations of northwestern North America. As the populations to the central and eastern regions of the continent have greater statures, it is reasoned that the decreased relative torso heights among these groups is a reflection of this allometry and not strongly related to climatic factors. Research by Tanner et al. (1982), Takamura et al. (1988), and Jantz and Jantz (1999) have argued that secular trends in stature increase are disproportionately contributed to by increases in lower limb length. Indeed, this change has been shown to occur within *one generation* among Maya that move to the United States (Bogin et al., 2002; Bogin and Rios, 2003), wherein the Mayan children had a better nutrition than either their parents or Mayan children raised in poverty in Guatemala. Although this is an extreme example (this kind of sudden, massive change in nutrition is likely without precedence in the archaeological record), it is an interesting example of nutrition as a confounding factor in the relationship of climate with morphology. Jantz and Jantz (1999), in fact, cite the positive scaling of the tibiae as the main contributor to this variation. Therefore, one would expect higher crural indices in overall taller individuals. Thus, the

effects of nutrition cannot be ignored as possible effects on climatic adaptation; this is discussed at greater length below in section 3.3.

On the whole, then, there is some indication that New World populations show the same ecogeographic patterns in morphological variation as those observed in the Old World. Some trends, such as those in bi-iliac breadth, may be more muted than those found when comparing Europeans and Africans. In addition, some morphological characteristics, such as stature, display unique patterns in recent North American and South American populations that may be related to genetic affinities or to cultural effects. A compelling result is the great diversity suggested by Jantz et al. (2007). Yet, if any general conclusion may be drawn from these studies of variation in the New World, it is that much is still unknown about morphology and its variation through time and across geography in this area of the globe.

3.2.3: Mechanisms: experimental models and clinal theory

Humans exhibit clines in body morphology relative to geography and climate, though there are interesting exceptions in the New World. Under the assumption that the ecogeographic patterns defined under Bergmann's and Allen's rules are largely influenced by an animal's thermoregulation, what mechanisms would create and maintain observed clines in body size and shape (or, more correctly, relative surface area)? As mentioned at the beginning of this chapter, phenotypic plasticity might allow for variation in the relative size and shape of animals' core bodies and extremities, and therefore allow for adaptation within the ontogeny of an organism. Alternatively, individuals who exhibit better-adapted morphologies would be more reproductively fit. This would change relative size and shape over a series of ontogenies.

A series of experiments have been conducted on various species over the last half-century to ascertain if animals are ontogenetically plastic in their body and limb proportions and shape. Most of these have occurred in the laboratory, wherein littermates of species are raised in separate, controlled environments and compared after various periods of growth (reviewed in Holliday, 1995, page 52). Six of these laboratory experiments are of special note: Barnett, 1965; Lee et al., 1969; Weaver and Ingram, 1969; Noel and Wright, 1970; Rae et al., 2006; Serrat, 2007. Rats or mice were raised in different ambient temperatures in all of these experiments, except for the studies by Weaver and Ingram, who utilized pigs. Some experiments tested heat stress, cold stress, or both on different experimental groups. All of the experiments arrived at the same results: phenotypes—tail lengths, ear lengths, limb lengths, body masses, and nasal aperture shape—all respond to the effects of temperature in directions that would be predicted by the ecogeographic rules. Therefore, there is some supporting evidence that, in mice and pigs, phenotypic plasticity allows for full siblings (or even the same individual) to exhibit differential growth in relation to ambient temperature. Furthermore, Lee et al. (1969) suggested that decreased blood flow resulting from shunting in cold-environment groups is retarding the proliferation of new bone growth at epiphyseal plates during modeling. However, Serrat (2007) grew metacarpal bones of mice in nutrient solutions, free of vascular supply, and showed that the same growth stunting occurs when the bones were grown in cold temperatures¹⁵. The mechanism that controlled the slower development has not been determined, but could relate to cellular metabolism, temperature-sensitive proteins, or intercellular communication (Serrat, personal communication, 2007).

¹⁵ Not only did Maria Serrat grow the bones free of vascular supply, but took them from the *same animal* (i.e., bones from the left and right sides). Therefore, she had, ostensibly, absolute genetic control over the experimental results.

Yet, do controlled laboratory results reflect real world responses of animals to climate? There are very few studies outside of human variation that assess this, and most human studies (as noted above) demonstrate a retention of limb and body proportions in the children of individuals who move from one climatic extreme to another (Froelich, 1970; Benoist, 1975; Eveleth, 1986; Feldesman et al., 1990; cf. Tanner et al., 1982). Perhaps the most salient non-human, “real world” studies are those reported by Paterson (1996) and by Clarke and O’Neil (1999), in which measurements were taken on troops of *Macaca fuscata* (Japanese macaques) transplanted from Japan to Texas, to Louisiana, and to Oregon. They found that the Texas and Louisiana macaques have longer limb lengths than those in Oregon, and that the Oregon troop exhibit longer trunks. Moreover, Paterson compared the growth patterns of these monkeys, describing the Oregon troop as having larger overall measurements and lower growth rates while the Texas troop has a much faster growth rate (especially for the limbs). These reflect morphological patterns anticipated by Bergmann’s and Allen’s rules, and corroborate the rapid adaptations observed in more controlled laboratory settings. Differences in food availability were not taken into account in this study, however, and so higher weights observed in the Oregon troop may have related to more food as much as to colder climates. Without more controlled “natural” experimentation like this, however, the results of Patterson, and Clarke and O’Neil remain uncorroborated, though compelling, anecdotal¹⁶.

There is some evidence, then, that changes in body proportions among non-human mammals may occur within ontogeny. Such experimental evidence is not available for humans. It has been documented that adult limb proportions are found among subadults:

¹⁶ Note, however, Weinstein’s (2001) dissertation results, which indicate that rhesus macaques transplanted to Puerto Rico do not exhibit these rapid adaptations.

Inuit juveniles exhibit adult proportions in limb bones early in ontogeny (Y'Edynak, 1978; Cowgill, 2006), and Inuit children have relatively shorter lower limbs than children of Old World descent in the United States (Johnston et al. 1982).¹⁷ Thus, there is support for genetic variation in the development of limb proportions, though it is not certain how much climatic influences on ontogeny augment this apparent genetic variation. Humans may have the same kind of morphological plasticity shown in experimental models, or, through selection and fixation (i.e., genetic accommodation or the Baldwin effect), the phenotypic plasticity observed in these other species has been (greatly) reduced in humans. Indeed, humans might have had a range of phenotypic plasticity, but individuals with more developmental plasticity or a developmental inclination for a more selectively fit body proportion might have experienced increased survival, bearing children with similar plasticity or phenotypic variants. Accumulated neutral mutations might have, over time, reduced this plasticity or fixed the fitter phenotype in the population. Climatic factors could therefore still play a role in some populations' phenotypes, assuming a degree of phenotypic plasticity responsive to climatic factors (or other factors correlated with climate), though genetic mutations could have reduced or minimized this degree of ontogenetic change in response to environment. The two evolutionary mechanisms—change through ontogeny or across multiple ontogenies—are not mutually exclusive.

So, if humans *had* phenotypic plasticity that eventually led to genetic accommodation of morphological traits, how did the reported clines in the Old World (and muted clines in the New World) develop? In order for the clinal patterns in morphology to develop under either

¹⁷ Arya et al. (2002) and Livshits et al. (2002) also argued that body proportions are generally highly heritable among human populations from various Indian castes and populations from central southern Asia. Furthermore, some traits—such as relative sitting height—were more plastic than other variables observed in the cranium or the postcranium, such as nasal breadth. As these depend on observed phenotypes, however, it is difficult to assess if common environmental factors are influencing the estimated heritabilities.

or both evolutionary mechanisms, certain basic principles of clinal theory would have to be maintained (Barton and Hewitt, 1985). Rather than discuss this mathematically (see papers by Nicholas Barton for these equations, proofs and arguments), a conceptual model follows.

All clines, in a simplified model, consist of the meeting of two populations exhibiting different phenotypes and/or (more importantly) carrying different alleles for one or multiple traits. The interface between these two populations is generally referred to as a hybrid zone, where members of the two populations experience gene flow. When this interface is not impeded by environmental factors (e.g., a river or similar geographic obstruction), it has the tendency to shift as conditions in population distribution (or structure), fitness or gene flow change¹⁸. Hybrid zones are maintained by limited gene flow between the neighboring populations or strong selection against the phenotypes of the bordering population. If the dispersal of genes (or people) from one side of the zone exceeds the rate at which selection removes their phenotypes (e.g., the population on one side of the zone has greater fitness across the cline), then the hybrid zone will shift and, eventually, the cline may collapse. Alternatively, steep clines, wherein little gene flow or extremely high selection occur between neighboring populations, could result in genetic isolation between the two populations, and therefore eventually result in allopatric speciation (though, if gene flow is impeded for mate-choice reasons, parapatric speciation would result).

If the experimental models accurately demonstrate a tendency for mammals to have developmental plasticity in core body and extremity size and shape, how does this develop into a cline? Assume that a single population lacking morphological specializations akin to those predicted by ecogeographic rules occupies a wide climatic range. Over a course of a

¹⁸ In these instances, the hybrid zone is referred to as a tension zone (Key, 1968). Width of this zone depends both on overall fitness of the hybrid and the allowance for gene flow across geographic or other barriers.

few generations (influenced by rapid adaptation during ontogeny), individuals living in the colder margin of the climatic range develop a phenotype typical of that environment, as do individuals on the warmer margin; their offspring, however, maintain most of the original developmental plasticity. Importantly, adults have adapted morphologies to a particular climate zone. Gene flow in a temperate hybrid zone would restrict speciation, but adults would be less fit were they to migrate to a climatic zone selectively different from the one to which their morphologies are adapted. It is easily conceivable, under this model, that over a course of many generations, neutral mutations affecting this developmental plasticity could accumulate without deleterious effects to overall fitness, and therefore restrict the expressed phenotypes in offspring until they appear to be or are genetically fixed.

In fact, taking into account mitochondrial DNA data from arctic populations (see Chapter 2) and the observed early development of adult limb proportions among the Inuit, this clinal model may be directly applicable to one example in North America. The lack of many temperate population mtDNA haplogroups among arctic populations suggests that there was limited gene flow or no gene flow between Inuit groups and subarctic groups (Zlojutro et al., 2006). Though multiple factors, including morphological adaptation to climatic factors, would have been involved in determining total fitness of these humans, the inability of temperate populations or arctic populations to be equally fit in each other's climates would have reinforced the fixation of their respective morphologies (or, at least those of the Inuit). Gene flow might have continued through intermediary populations along the Pacific Northwest coast and the Western Plateau (which, as stated, have exhibited gene flow with populations from the Great Basin), but the gradient was sufficient enough to maintain a steep cline between arctic populations and all of the populations to the south. Without analysis of

more skeletal remains from these regions (which will take place in the coming chapters), however, this hypothesis is only conjecture.

3.2.4: Physiology among humans

As noted in section 3.2.1, the effects of morphological, physiological, and cultural adaptation are likely additive (even synergistic), providing collective advantages in surviving the many environments inhabited by humans. Though this dissertation does not directly consider the effects of physiology in helping humans adapt to climatic factors, they are noted here. More comprehensive summaries may be found in Roberts (1978) and Ruff (1994a).

Multiple authors (e.g., Scholander, 1955; Irving, 1957; Wilber, 1957) have argued that physiological mechanisms represent the primary adaptation of humans to climatic extremes, though their all-or-nothing thinking has largely been rejected (e.g., Newman, 1956; Garn, 1958; Schreider, 1964; Ruff, 1994a; Holliday, 1997a; Little and Steegmann, 2006; Steegmann, 2007). With the various empirically observed patterns in human morphological variation, there is a great amount of support for the importance of morphological adaptation in relation to climatic factors. However, the observations of these authors¹⁹ have introduced interesting and important additional mechanisms to those cited by morphologists regarding animals' adaptations to climate.

The principal results of physiology studies have focused on responses to heat versus responses to cold. In heat acclimatization, most physiologists have focused on the importance of lowered basal metabolic rates, effective sweating mechanisms (allowing for heat transport but minimizing water loss), blood flow dynamics (vasodilation), and the rate of

¹⁹ Unquestionably, not all of their observations should be regarded equally. For example, Wilber (1957) and Strydom and Wyndham (1963) published studies that were immediately criticized for poor assumptions, bad sampling, and unclear methodologies (see Garn, 1957, and the comments published at the end of Strydom and Wyndham).

response to heat stress (e.g., Robinson, 1968; Newman, 1970; Hanna et al., 1989).

Conversely, physiologists examining the acclimatization of humans to cold environments have cited the effectiveness of high basal metabolic rates (mediated through thyroid hormones), vasoconstriction, and shivering in reducing the stress of heat loss, in addition to increased amounts of low-vascular insulation (i.e., fat) (Steegmann, 1972, 1975; Gallow et al., 1984; Leonard et al., 2005; Snodgrass, 2005). A common conclusion that these authors have drawn is the tendency for differences in these mechanisms to relate to populations of different ancestries. For example, Inuit have universally been demonstrated to maintain higher skin temperatures when exposing hands or feet to ice baths than Europeans or even individuals that have experienced long-term adult exposure to colder environments (Little and Steegmann, 2006). This is likely a combination of more effective vasodilation, higher basal metabolic rates, as well as the lower relative surface area of Inuit hands.

One argument made against the need for extreme metabolic and morphological adaptations in more recent humans has been the effect of cultural buffering. Eyed needles are among the tools associated with the Clovis industry (Collins, 1999), and so clothing was most likely a technology found among the earliest inhabitants of the Americas.

(Anecdotally, the diamond-plait textile mat found with the Spirit Cave early Holocene skeleton is incredibly complex, unique to the Americas, and demonstrates advanced hand-loomed abilities present 9500 yBP. Undoubtedly, this ability extends much further back in time.) Fire was also a common element of human technology, as was shelter construction, among the earliest possible migrants to the New World (Powell, 2005). Thus, some buffering from the effects of climate in physiology and morphology was likely. This has been an argument for why modern humans, exposed to the same extreme environments as

Neandertals (assumed to possess less effective buffering technologies), never developed the Neandertal extreme morphologies (Holliday, 1995), although there were likely multiple reasons for this discrepancy. It is important to note, however, that clothing and other technologies will *reduce* the effects of temperature and precipitation, but these effects were never wholly *removed* by technology in the archaeological record. Following the same synergistic model of morphological and physiological responses to environmental pressures, culture would serve as another contribution to a mosaic of adaptations that have allowed humans to colonize high latitudes and altitudes. Indeed, it may also be that the effects of sudden climatic shifts—heat “waves” and cold “snaps”—served as an additional selection pressure on physiology, morphology, and technology (Hanna and Austin, 2006; Little and Steegmann, 2006).

3.3: Phenotypic responses to subsistence and activity

In addition to morphological responses to climate, a vast literature has documented human adaptation and change in response to subsistence—which includes diet and the activities associated with the acquisition of food (or movement in general). Often, these are examined separately from studies examining morphology and climate, though they are commonly noted as another set of factors influencing morphological variation. As already mentioned above, however, the effects of changes in nutrition on the skeleton may have confounding consequences on morphologies thought to represent adaptations to climate alone (i.e., nutritional effects on stature might be related to positive allometry in the lower limb, which in turn affects relative sitting height and possibly crural index). For this reason alone,

the effects of subsistence must be analyzed in tandem with studies of morphological variation in relation to climate.

3.3.1: Morphological responses to nutrition

The effects of variation in nutrition on humans have generally been examined in two non-exclusive categories: the effects on disease and the effects on growth. Although the effects of nutrition on disease (e.g., dental caries, rickets, anemia, etc.) are interesting, those conditions that affect overall skeletal morphology are rare and almost universally excluded in studies of (normal) morphological variation. Thus, the discussion in this subsection is concerned exclusively with nutritional effects on variation in growth and development.

One of the most commonly observed aspects of populations in relation to diet and nutrition is stature. Stature has a potential maximum dictated by inheritance, but various nutritional and hormonal effects have been shown to affect the development of long bone lengths and overall body mass. These are developmentally plastic traits, especially the rate and timing of epiphyseal closure of long bones (Bogin, 1999). As Larsen (1995) succinctly stated, “growth-retarded children [due to poor nutrition, food shortages or related stress] should be short-statured adults.” A number of modern studies have demonstrated this connection between poor nutrition, retarded growth in children, and reduced adult stature (e.g., Fogel et al., 1983; Bogin, 1999, and papers reviewed therein). Related to stature but not as often reported is the relationship between nutrition and body mass (e.g., Stini, 1974; Malina, 1985). As studies of ecogeographic variation imply that body breadth is fairly stable within populations relative to stature (Ruff, 1994a), the differences in body mass are therefore likely attributable to changes in stature and variation in the amount of fat or muscle mass, rather than a proportional change in body breadth.

In archaeological contexts, the analysis of stature variation—or any other morphological characteristic—is often restricted to comparisons among adults, as the remains of children are rare. Additionally, juvenile bones lack epiphyses, which demonstrate various developmental rates (e.g., so-called catch-up growth versus normal developmental patterns), are somewhat difficult to age (and nearly impossible to sex), and lack comparative data from many clinical studies of longitudinal growth to clarify these two issues (Goodman and Martin, 2002; compare with Ruff, 2007, for new methods by which to account for these uncertainties). However, juvenile development within a population would be the most informative about the effects of dietary stress and social hierarchy. A disadvantage of examining adults alone is the lack of information about the direct effects of nutritional differences on patterns of growth, as well as the elimination of the portion of the population that is the most stressed (the deceased juveniles) (Larsen, 1997; Goodman and Martin, 2002).

Thus, adults reveal less variation in response to environmental effects than are present for an entire population. Indeed, the same argument could be made for general comparisons of morphology as a whole. However, a counterargument is that looking at adults demonstrates those individuals who are *best adapted* to a given environment, and therefore represent the optimal phenotype for comparing differences within and among populations.

This caveat aside, a plethora of studies have examined stature differences within adult skeletal samples through time (i.e., secular change). Most of these have been limited to circumscribed temporal and regional studies, such as Lambert's (1993) paper, in which she implicated a shift from a marine hunter-gatherer mode of subsistence to a fishing-intensive diet among populations of the northern California Channel Islands as the cause for decreasing stature beginning around 2500 yBP. Longer-term studies of New World

archaeological and living populations have most notably focused on Mesoamerica. This research has demonstrated that, among the Maya, the intensification of agriculture and high population densities (leading to nutritional stress and higher disease loads), as well as the adoption of a highly socially stratified society, led to a secular trend for decreased stature in some locations, such as Tikal (Haviland, 1967), but not universally (Danforth, 1994, 1999). In contrast, the Zapotec, who lived north of the Maya in the Oaxaca Valley, never exhibited a decrease in stature (Malina et al., 1983). The Zapotec and Mixtec populations from this valley did have social stratification, but skeletal evidence implies that this social structure did not have as conspicuous an effect on stature. Interestingly, modern Maya remain generally depressed in stature (due to civil war, extreme poverty, and poor nutrition) (Bogin and Keep, 1999; Danforth, 1999), while the Zapotec-speaking populations of the Oaxaca Valley in Mexico have experienced an increase in stature over the last forty years (Malina et al., 2004), coupled with an evident improvement in dietary diversity, more sanitary housing, and lower incidents of disease. It should be noted that smaller statures have been proposed by some to be adaptively advantageous to conditions wherein food is scarce (e.g., Stini, 1971), though more recent authors have discounted this idea given the higher mortality and susceptibility to disease in shorter individuals (though this correlation likely reflects common causes and not a direct relationship between stature and health) (Bogin, 1995; Danforth, 1999; Kemkes-Grottenthaler, 2005).

An interesting result reported by Haviland (1967) was the apparent *lack* of secular change among female statures at Tikal, while male skeletons clearly indicated decreases in stature during the Mayan Classic Period. Haviland attributed this to a generally low class status for females in Mayan society—given that the majority of female skeletons were excavated

outside of higher status tombs—that did not change through time. It is arguable that, as most of the females were recovered outside of tombs, this represents a sample bias among the female sample for individuals from lower social status. Alternatively, this could reveal a significant difference between males and females in response to nutritional stress. Stini (1974), in reviewing a cross-section of human population data and experimental results from mammal species, demonstrated this sexual dimorphism in the effects of nutritional deprivation. However, much of this is restricted to body mass and not stature in his study; males have lower body mass (and, to a lesser extent, stature) compared with females in nutritionally stressed populations, which Stini attributed to physiological responses (e.g., adrenal hormones) that slow growth rates, and therefore delay maturity. (Note, though, that this would also affect overall growth, including stature.) As males have a longer period of primary growth, insults to growth would attenuate the faster or prolonged growth experienced by males. This concept has been termed “female buffering,” and has been extended to a general concept that environmental stress has less effect on the overall morphology of females than of males in the same population (e.g., Ruff, 1994a).

An additional general finding indicated by the studies of Mesoamerican populations is the ambiguous effect of the development of agriculture on stature. Some authors surveying changes in stature (and overall health) over centuries and multiple populations have stated that a general decline in nutrition accompanied the development of agriculture (Cohen and Armelagos, 1984; Bogin and Keep, 1998; Steckel et al., 2002). These researchers contend that hunter-gatherers are better buffered against the effects of seasonal food variation and experienced less developmental stress from protein deprivation (implicated as essential to growth) or disease. However, as pointed out by Larsen (1995), citing various other studies,

the evidence for universal stature reduction with the adoption of agriculture is ambiguous, because all agricultural developments did not consist of the same diets. That is, some populations adopted agriculture but maintained a higher level of dietary diversity and higher protein intake than other populations. Indeed, if the evidence noted above from the Maya and the Zapotec is an indicator, the intensification of agriculture and the development of more socially stratified societies did not always result in significantly reduced health.

One problem cited by a number of authors examining New World archaeological remains has been the lack of accurate methods by which to estimate statures (e.g., Haviland, 1967, Malina et al., 1983). The researchers collaborating in the Western Hemisphere health project (Steckel and Rose, 2002) skirted this issue by applying available formulae (some published, such as Sciulli et al., 1990, and others unpublished, such as those used by Storey et al., 2002) to their samples²⁰. However, as others and I have commented on elsewhere (Holliday, 1995; Auerbach and Ruff, 2004; Raxter et al., 2006), the observed ecogeographic variation in intralimb proportions and relative lower limb length indicate that stature estimation equations must be carefully matched between a reference population and the skeletons whose statures are being estimated. Although many authors either apply what they perceive to be the most appropriate available formula for estimating statures (e.g., using the Ohio sample generated by Sciulli et al., 1990, for populations from California), or forego stature estimation altogether and compare femoral lengths instead as a proxy for stature, the problem persists and is a minor caveat to the results reported by some of the authors cited above.

Few studies have addressed the effects of subsistence on other morphologies (except cortical bone density and strength, which is discussed below in the next section). As noted

²⁰ There are a number of problems and oversights associated with the Western Hemisphere project, many of which have been discussed by Wentz (2006). The project was ambitious, but it ignored a number of factors (e.g., body mass) in its population comparisons.

previously in this chapter, a growing literature has demonstrated that populations that have experienced sudden dietary and socioeconomic improvements exhibit rapid stature increases in their children (Tanner et al., 1982; Takamura et al., 1988; Ali et al., 2000; Bogin et al., 2002; Bogin and Rios, 2003; Malina et al., 2004). All of these studies have demonstrated that these sudden stature increases are disproportionately contributed to by lower limb length; that is, lower limb length exhibits positive allometry in relation to increases in stature. In turn, there is some forensic evidence that the tibia has positive scaling relative to femoral length in increases of lower limb length (Meadows and Jantz, 1995). Note that Meadows and Jantz (1995) also demonstrated that upper limb length scales negatively with increases in lower limb length and with stature. These effects have been reported to be greater in males, who exhibit greater increases in stature in response to nutritional improvement (Jantz and Jantz, 1999; Malina et al., 2004). This lends further support to the idea of female buffering. Malina et al. (2004) published mean height, sitting height, and lower limb lengths for the Oaxaca before and after the rapid secular change. Although these clearly demonstrate greater increases in lower limb length than in sitting height, it is important to note that the relative sitting height to overall stature (calculated from the reported data) does not change at all for females, and only decreases a little for males (by half a percent!). The apparent greater lower limb length increase does not impact relative sitting height in this study as much as these authors' descriptions would imply. Thus, although there is undoubtedly a slight allometric effect on lower limb length with increasing stature, it may not significantly affect the proportions of a population controlled by other environmental and genetic factors. In fact, Bogin et al. (2002) pointed out that, while there are changes in proportions, the ancestral proportions are not lost completely in events of rapid secular change in stature.

One other morphology examined in relation to nutrition is craniofacial change in relation to masticatory stress (Carlson and van Gerven, 1977; Hinton, 1983; Sardi et al., 2004). Experimental models have demonstrated that the hardness of diets affect palate shape (Beecher et al., 1983), mandibular ramus and condyle shape (Giesen et al., 2003), and, most importantly, transverse dimensions in the crania (Lieberman et al., 2004). Narrower and longer crania would allow for a longer moment arm for the muscles of mastication, and therefore would increase their power in bite force. Less masticatory loading was implicated by Sardi et al. (2004) as resulting in narrowing of the face and decreases in overall size of the craniofacial skeleton. Sardi et al. (2006) further demonstrated that the transition to agriculture from a generalized hunter-gatherer subsistence in Patagonia resulted in cranial size decreases and a reduction in structures related to mastication. Indeed, authors examining the dolichocephalic crania of the populations from Tierra del Fuego and the Inuit have implicated their tough diets as a causal factor in their skulls' robusticity and shape (e.g., Hernández et al., 1997). Therefore, changes in subsistence may also confound potential climatic effects on cranial index, facial index, and cranial size.

3.3.2: Morphological responses to activity: robusticity and asymmetry

In addition to the effects of subsistence on overall stature, body mass, and craniofacial shape, the activities associated with the acquisition of food and overall lifestyles also have a significant effect on the strength and properties of bone. The strength of a bone scaled to body size and shape²¹—termed its robusticity—has been shown to correspond to patterns of mechanical loading throughout primary growth and into adulthood (Ruff et al., 1993), as briefly reviewed in section 3.1 above. Ideally, the analysis of robusticity utilizes cross-

²¹ Note that Ruff (2000a) argued that the best method for scaling the strength properties of bone is still uncertain, but that comparing raw strength measurements alone is misleading.

sectional data (i.e., known cortical bone thickness), rather than external dimension data, as this more correctly reflects the strength properties of bone (O'Neill and Ruff, 2004).

External measurements, however, still provide an indication of different strength properties of bones when compared with like data (Ruff, 2000a).

This relationship between robusticity and subsistence has been shown to be especially observable in the diaphyses of limb long bones (Wescott, 2001, 2006; Wescott and Cunningham, 2006; Stock, 2002, 2006; Stock and Pfeiffer, 2004). Generally, the effects of mobility (which is tied to subsistence) should be differentially evident on lower limbs (high mobility on land) and upper limbs (high mobility on water). These are commonly examined using measurements from the femur and from the humerus, respectively (Ruff, 2006). As upper limbs are also used for a multitude of manual tasks, including food preparation, the relationship between humeral robusticity and water transportation are somewhat more difficult to parse out.

The effects of locomotion on the femur are best observed at the 50% midshaft of the diaphysis, as this region is less sensitive to the loading effects of different pelvic morphologies (Stock, 2002). Studies have indicated that the ruggedness of terrain has a differential effect on the robusticity of femora (Ruff, 1999, 2006; Wescott, 2006).

Populations that live in more mountainous regions exhibit greater femoral diaphyseal robusticity than populations living in coastal or plain terrain. Examinations of femoral robusticity in pre-agricultural and agricultural populations from the coast of Georgia (as well as the Pecos Pueblo sample from New Mexico) by Ruff et al. (1984) demonstrated a trend toward lower amounts of robusticity in the agricultural populations, a tendency demonstrated as well in other studies (Ruff and Larsen, 1990; Larsen, 1993). The conclusion from these

studies is that greater amounts of sedentism among these agricultural populations resulted in less mechanical loading of the lower limb. Agricultural populations are also distinguished by having decreased sexual dimorphism in femoral diaphyseal robusticity, whereas hunter-gatherers (and even European Middle Paleolithic samples) show higher strength in the femoral midshafts of males than females (Ruff, 1987, 2006; Wescott, 2001). Despite these differences in sexual dimorphism, there is an overall trend for rounder femoral diaphyses in later populations (especially among males), indicating decreasing mobility through time in the Americas. Decreases in bone density were also noted among Anasazi and Pueblo populations from the U.S. Southwest after the coalescence of populations following the major droughts of the Medieval Warming (see Chapter 2), associated most likely with nutritional stress; that these trends were more evident in males was further used to support the concept of female buffering (Brock and Ruff, 1988). In the Great Plains, these overall temporal trends were muted and the effects of the adoption of horticulture were not as severe as those reported among samples from the Southeastern U.S. and the U.S. Southwest (Cole, 1994; Ruff, 1994b). However, as these populations had a tendency to maintain high mobility (especially among males), even after the adoption of horticulture, this result is not surprising.

The robusticity of the upper limb—especially the diaphysis of the humerus—has been examined for relationships with activities associated with subsistence in multiple samples from the New World. Bridges et al. (2000) demonstrated that the introduction of maize in the Illinois Late Woodland period is associated with greater humeral diaphyseal robusticity among females, which then decreases in the following Mississippian period. This trend was also evident for both sexes in the Tennessee River Valley (Bridges, 1989). It is likely that these differences were the result of the adoption of a new cultivar and the associated

technologies for its processing. As technologies improved for grinding maize, the amount of observed robusticity in the humerus decreased. These changes were not observed by Ruff et al. (1984) in the Georgia coast sample, or by Wescott (2001) in samples from the Great Plains. Again, this may relate to different technologies, different intensity of processing of food items, or the overriding effects of other activities (or, in the case of the Georgia coast, lack thereof).

Some of these “other activities” include the effects of different modes of mobility. In observing the great robusticity of the humeri of Aleuts, Churchill (1994) noted that this morphology was most likely related to their maritime subsistence and mobility. Stock and Pfeiffer (2001) distinguished mobility among populations by comparing humeral and femoral strength: Andaman Islanders (who were seafaring) have higher humeral robusticity relative to femoral robusticity in comparison with Late Upper Paleolithic South African samples, who have been modeled as highly mobile terrestrial hunter-gatherers. Stock (2002) further demonstrated this discernment of mobility, and added that the effects of rowing are more evident in the robusticity of the radial diaphysis. He attributed this to greater developmental plasticity in the distal element, or, more likely, greater mechanical loading experienced on the forearm versus the arm (Stock, 2004). Interestingly, Weiss (2003) found a gradient among populations that engaged in maritime activities: populations that used fluvial or other freshwater travel have lower amounts of diaphyseal robusticity than those traveling inland and on the sea, and both of these groups have much lower diaphyseal robusticity relative to maritime rowers. Weiss (2003) attributed this difference to the amount of work necessary to navigate ocean waters versus rivers, though differences in technology should also be taken into account. As Ruff (2006) commented, Weiss’s description of high humeral robusticity in

Alutiiq females relative to males—which she attributed to greater overall activity levels among the Alutiiq—is muted when considering sexual dimorphism in humeral robusticity relative to femoral robusticity. Comparatively, Alutiiq males have considerably stronger humeri than females when accounting for femoral strength.

Differences in upper and lower limb morphology in relation to activity do not occur only in robusticity. They also vary with subsistence practices and between the sexes in directional bilateral asymmetry. The patterns, possible causes, and population variation in limb directional bilateral asymmetry have been written about extensively, and recently reviewed by Steele (2000) and by me (Auerbach and Ruff, 2006; Auerbach and Raxter, in review). Generally, all human populations show little asymmetry in the lower limb (most likely in response to the equal loading of lower limbs in locomotion), but display considerable variation and a pronounced, generally right-side asymmetry in the upper limb. Lengths of limb bones and their articular surfaces exhibit less asymmetry than their diaphyseal breadths, which likely ties into differential developmental plasticity in these bone regions (see section 3.1). As summarized in Auerbach and Ruff (2006), considerable differences in habitual behaviors among populations lead to increased or decreased asymmetry in average diaphyseal breadth, as exercise has been shown to have differential effects in living humans preferentially using one limb (Jones et al., 1977; Ruff and Jones, 1981; Trinkaus et al., 1994). Therefore, one would expect lower amounts of directional asymmetry in the upper limbs of habitual rowing individuals compared with individuals habitually engaged in unimanual tasks, such as using a bow and arrow.

A final comment on environment and morphology

As demonstrated in the discussion above, multiple environmental factors have been

implicated as contributing to the morphology of the skeleton, many of which likely interact with traits of varying developmental plasticity and environmental response. This brief survey also reveals that there is potentially a great amount of morphological variation in the New World in relation to climatic and subsistence factors, among other external influences. In the upcoming analysis, these are addressed individually and together, but it is important to note that at no time in these analyses should the correlations of environmental factors with morphological variation be interpreted as a strict causal relationship. As already made evident in this chapter, there are likely multiple interactions among these external factors. Additionally, and perhaps more importantly, there are additional factors that likely underlie the environmental variables under consideration, or tertiary variables not obvious and therefore not taken into consideration. For example, the determination of long bone growth may be a combination of genetic and hormonal control, overall nutrition, climate (e.g., temperature affecting rates of metabolism), and physiological stress (e.g., from disease). Attempting to separate out the individual effects of these is useful, but it is still their combined influence that yields the final development of the bone.

3.4: Folded in a single party: hypotheses

Based on the broad range of topics presented above and in Chapter 2, a series of specific hypotheses, devised from the previous evidence, are tested in this dissertation. These hypotheses are organized into three general groups: 1) general morphological variation and integration between morphological features; 2) variation in relation to climate and geography; and 3) variation in relation to subsistence. The following are the hypotheses tested:

Hypothesis group 1: Morphological variation in the Americas

H1.1: Cranial morphology will significantly differ among samples across geography, as will postcranial morphology (i.e., among all regions considered).

- a. Morphologies will significantly differ among samples tested within each temporal period, as well as those examined across the entire temporal range of the sample (i.e., humans in the New World are never morphologically homogeneous).
- b. New World humans from more recent temporal periods will meet or exceed the range of variation in the same morphologies in temporally recent samples from Europe and Africa (an established morphological cline).

H1.2: Morphologies previously demonstrated to be sexually dimorphic in Old World analyses will also be sexually dimorphic within samples from the Americas.

- a. Cranial index, brachial index, relative torso height, stature, body mass, and body breadth dimensions will be sexually dimorphic.
- b. Nasal index, facial index, crural index, and interlimb index will not be sexually dimorphic.

H1.3: Patterns of variation among samples in morphological indices will be similar in the crania and postcrania.

- a. Cranial dimensions that reflect breadth will have greater variance than height measurements in all samples.
- b. Distal elements or dimensions (e.g., lower limb length) will have greater variance than proximal elements in all samples.

Hypothesis group 2: Morphological variation in relation to climate and geography

H2.1: Morphologies will significantly covary with temperature.

- a. Differences among samples in cranial index, cranial module, facial index nasal index, intralimb indices, relative torso length, upper body breadth, absolute bi-iliac breadth, and body mass will significantly covary with temperature: colder climate samples will have relatively rounder and larger crania, wider faces, narrower nasal apertures, longer torsos, wider bodies and higher masses.
- b. Postcranial morphologies will show higher correlations with climatic factors than cranial morphologies, with the exception of nasal index.
- c. Extreme temperatures—maximum mean temperature of the warmest month and minimum mean temperature of the coolest month—will have higher correlations with morphologies than mean annual temperature

H2.2: Differences in atmospheric moisture—as indicated by levels of precipitation—will covary with morphology.

- a. Humans in drier warm climates will have relatively longer limbs, relatively longer distal limb segments, and relatively narrower noses than those in wetter warm climates.
- b. Humans in wet climates will have lower body masses than those in dry climates.

H2.3: Samples that significantly differ morphologically in postcrania from other samples within regions of similar climate indicate recent migrants.

Hypothesis group 3: Morphological variation in relation to subsistence

H3.1: Morphological differences in select dimensions will vary among subsistence groups in the postcrania but not in the cranial dimensions except cranial index.

- a. Cranial index, stature and body mass will significantly vary among subsistence groups when taking climatic factors into account as covariates: agriculturalists will have relatively rounder crania, lower body masses and shorter statures than hunter-gatherers.
- b. Horticulturalists will not significantly differ from hunter-gatherers in any morphologies when climatic factors are taken into account.
- c. Although there is a reported allometry in the length of the tibia relative to the length of the lower limb in taller individuals, there will be no significant difference in relative torso height or crural index when climatic factors are taken into account.
- d. Nasal index, brachial index, and body breadth will not significantly differ among subsistence groups.

H3.2: Females will exhibit less variation in stature or body mass among subsistence groups than males (as an effect of “buffering” from environmental factors).

H3.3: The robusticity and bilateral asymmetry of limb bone diaphyseal breadths will reflect differences among subsistence groups.

- a. Hunter-gatherers will have significantly higher values for robusticity in both humeral and femoral diaphyseal breadths than horticulturalists or agriculturalists. This will be more apparent in males (after scaling robusticity relative to body mass), as it would indicate sexual division of activity.

- b.** Marine hunter-gatherers will have the highest robusticity in humeral diaphyseal breadths, whereas other hunter-gatherers will have higher femoral diaphyseal breadth robusticity.
- c.** Agriculturalists and horticulturalists will have similar amounts of robusticity in both upper and lower limbs, and these two groups will not significantly differ from each other in humeral or femoral values.
- d.** General patterns of asymmetry shown previously among human groups will be found among the samples from the New World (e.g., greater amounts of upper limb asymmetry compared to lower limb asymmetry, higher amounts of asymmetry in the diaphyses than in lengths or articulations). Marine hunter-gatherers will have lower upper limb directional bilateral diaphyseal breadth asymmetry than other subsistence groups. Agriculturalists and horticulturalists, however, will have lower amounts of diaphyseal breadth asymmetry than hunter-gatherers.

Chapter 4

METHODS

“DATA! DATA! DATA!... I CAN’T MAKE BRICKS WITHOUT CLAY.”

- Sherlock Holmes, The Adventure of the Copper Beeches

This chapter describes the data sets, derived data, and statistical methods used to investigate the hypotheses listed at the end of Chapter 3 in the context of topics described in Chapters 2 and 3. One specific concern about the osteometric data—the presence of missing data values and the use of incomplete data in analyses—is reserved for special consideration in the following chapter. Much of the more detailed information on the skeletal sample, methods for taking measurements, formulae for calculating derived morphologies, and climatic data are placed into appendices at the end of this dissertation, in the interest of brevity and easy referencing. Instead, summaries of data are presented in this chapter.

In addition to describing methodological approaches, this chapter also considers the limitations on the data and the analyses used in this dissertation. In order to investigate sufficiently the diversity of the Americas before European contact and colonization, a great amount of information must be obtained. Humans lived in all geographic locations of the Americas previous to 500 yBP, including those that remain inhospitable. Representing all of these regions in a skeletal sample, throughout the entire temporal range of occupation, is a problem on multiple levels: skeletal preservation is inconsistent across the Americas, regions have been excavated unequally, and access to human remains in some areas has become increasingly difficult. In addition to the inherent skeletal sample limitations, which are discussed in more detail below (“Limitations,” Section 4.1.2), the cultural identities of many available skeletons are not known, are poorly documented, or contested by archaeologists. Add to this the difficulties introduced by uncertain population movements and relatedness

outlined in Chapter 2, and the use of archaeological samples to test the hypotheses of this dissertation is a somewhat daunting and difficult task. Moreover, the investigation and modeling of the climate of the past, despite recent advancements, remains highly incomplete.

These data gaps should not curb attempts to examine the morphological variation of American groups in relation to each other and to environmental factors. Rather, it is important to acknowledge that studies of this nature—as any other undertaken on other human groups, continents, or temporal ranges—are still among the first stages of comprehending human variation and adaptation. They are useful, even crucial, in developing the models for understanding these topics, which then inform further investigations. In perspective, more information is available for study now than was available even a decade ago: two well-dated and nearly complete skeletons from the early Holocene (Spirit Cave and Kennewick skeletons) have been identified in North America, as well as numerous skeletons in South America; the enacting of NAGPRA and First American laws have forced many collections in the United States and Canada to better document their collections (despite also leading to data loss through repatriation); and researchers are frequently adding more data to hone the understanding of past climate, population movements, and group genetic relationships and cultural affiliations.

4.1: The Archaeological Sample

Two thousand seven hundred forty-nine (2749) skeletons, ranging in completeness from single elements to fully intact, mummified skeletons, were observed and measured for the dissertation data set. The total sample represents 156 “sites”¹—individual burial grounds,

¹ Note that the term “site” refers to locations (or closely-affiliated locations) from which burials were retrieved, and the skeletons therein. “Sample” is used to refer to groups of skeletons used for the purposes of analysis. In the case of a site with a large number of skeletons, the two terms are synonymous.

affiliated burial grounds from the same location, or geographically proximate internment locations that are archaeologically linked. These skeletons were observed and measured at various institutions throughout North America. This group of skeletal measurements will be referred to as the primary osteological data set (POD). All skeletons date to before direct contact with European colonizers or shortly after (the latter is termed the “proto-historic” period). Only sites with available provenience data (geographic location of site, time period range for site, possible cultural or archaeological tradition affiliation) were chosen for measurement. The fundamental selection criteria for inclusion of a skeleton were that one representative of each of the four main limb bones (humeri, radii, femora, and tibiae) was present, completely fused, intact enough for osteometric measurement (length and the majority of the other measurements), free of major pathology,² and could be identified as belonging to the same individual. In the cases of some groups wherein crania associated with postcrania were poorly preserved and/or few in number, additional isolated crania were measured. Table 4.1 summarizes the sites observed and the number of skeletons measured. More detailed information about sites, site locations, cultural affiliations, subsistence categories (discussed in detail below), holding institutions, and time periods are provided in Appendix I. Appendix I maps show locations and temporal periods (see below) of sites.

Generally, sixty adult individuals per population (approximately thirty of each sex) constitute the maximum sample size, in order to maximize time available to collect data on all samples and to prevent overrepresentation of archaeologically large samples. Larger sample sizes, if available, were favored for sites likely to have had high intrapopulation

² Pathologies, however, are common throughout the POD. Major pathologies were those considered to be between 0.2% of the total sample (in manubria) and 8.7% of the sample (in lumbar vertebrae) exhibited non-trauma-induced pathologies that prevented the inclusion of metric measurements from those elements. A far greater proportion of the sample (nearly 15%) exhibited signs of healed trauma in the skeleton, although most of these did not affect measurements.

Table 4.1. Sites sampled in the primary osteometric data set (POD)

Site Name	Appendix I Number ¹	Site Location ²	Region ³	Number measured (♂/♀/?)
Aleutian Islands ("Pre-Aleut")	1	Alaska	Western Arctic	28 (12/16/0)
Aleutian Islands ("Neo-Aleut")	2	Alaska	Western Arctic	55 (37/18/0)
Ikogmiut	3	Alaska	Western Arctic	61 (30/30/1)
Kuskowagamiut	4	Alaska	Western Arctic	28 (14/14/0)
Point Barrow	5	Alaska	Western Arctic	29 (20/9/0)
Point Hope – Birnirk	6	Alaska	Western Arctic	1 (1/0/0)
Point Hope – Ipiutak	7	Alaska	Western Arctic	34 (18/16/0)
Point Hope – Norton	8	Alaska	Western Arctic	2 (1/1/0)
Point Hope – Tigara	9	Alaska	Western Arctic	44 (21/22/1)
Canyon del Muerto	10	Arizona	U.S. Southwest	30 (18/11/1)
Carter Ranch	11	Arizona	U.S. Southwest	16 (9/7/0)
Grasshopper	12	Arizona	U.S. Southwest	48 (27/21/0)
Knishba	13	Arizona	U.S. Southwest	25 (13/11/1)
Point of Pines*	14	Arizona	U.S. Southwest	10 (5/5/0)
Turkey Creek*	15	Arizona	U.S. Southwest	8 (4/4/0)
Pecan Point*	16	Arkansas	Southeastern U.S.	3 (1/2/0)
Boytt's Field*	17	Arkansas	Southeastern U.S.	2 (2/0/0)
McClure Place*	18	Arkansas	Southeastern U.S.	1 (0/1/0)
Rose, Potter Pl., Castile Pl., Lauratown*	19	Arkansas	Southeastern U.S.	17 (10/7/0)
Bear Creek	20	California	California	12 (6/6/0)
Blossom	21	California	California	49 (20/17/2)
Channel Islands (two groups)	22	California	California	26 (11/17/0)
Cook	23	California	California	19 (14/4/1)
Cuyama Ranch*	24	California	California	6 (2/4/0)
Ellis Landing	25	California	California	19 (12/7/0)
Hicks, Herzog, Augustine	26	California	California	17 (8/9/0)
Karlo	27	California	California	9 (2/7/0)

Jones	28	California	California	17 (9/7/1)
La Jolla	29	California	California	25 (11/12/2)
Mustang Mound	30	California	California	18 (10/8/0)
Napa Valley	31	California	California	1 (0/1/0)
Need 1	32	California	California	27 (15/12/0)
Point Sal	33	California	California	25 (17/8/0)
Ryan Mound	34	California	California	40 (20/17/3)
Tulamni*	35	California	California	6 (4/2/0)
Western Berkeley	36	California	California	11 (7/4/0)
Yerba Buena and Bayshore Mound	37	California	California	12 (10/2/0)
Yuma III	38	California	California	8 (4/3/1)
Ackmen / Lowry Ruin*	39	Colorado	U.S. Southwest	10 (4/6/0)
Yellow Jacket Pueblo*	40	Colorado	U.S. Southwest	3 (2/1/0)
Bayshore Mounds	41	Florida	Southeastern U.S.	17 (7/9/1)
Little Salt Spring	42	Florida	Southeastern U.S.	1 (1/0/0)
Palmer / Casey Key	43	Florida	Southeastern U.S.	45 (22/22/1)
Tick Island	44	Florida	Southeastern U.S.	5 (3/2/0)
Warm Mineral Springs	45	Florida	Southeastern U.S.	>13 (2/1/>10)
Windover	46	Florida	Southeastern U.S.	74 (43/28/3)
Irene Mound	47	Georgia	Southeastern U.S.	32 (13/19/0)
Albany	48	Illinois	Prairie & Woodlands	18 (11/7/1)
Calhoun County*	49	Illinois	Prairie & Woodlands	17 (12/5/0)
Dickson	50	Illinois	Prairie & Woodlands	53 (26/27/0)
Elizabeth*	51	Illinois	Prairie & Woodlands	8 (5/3/0)
Fulton County*	52	Illinois	Prairie & Woodlands	2 (1/1/0)
Jersey County*	53	Illinois	Prairie & Woodlands	33 (21/12/0)
Kuhlman	54	Illinois	Prairie & Woodlands	14 (8/6/0)
Modoc Rock Shelter	55	Illinois	Prairie & Woodlands	17 (7/10/0)
St. Clair County*	56	Illinois	Prairie & Woodlands	1 (1/0/0)
Wilson*	57	Illinois	Prairie & Woodlands	8 (6/2/0)
Indian Knoll	58	Kentucky	Southeastern U.S.	62 (29/29/3)

Brouillette	59	Louisiana	Southeastern U.S.	3 (3/0/0)
Glassell Plantation / Pickett Landing*	60	Louisiana	Southeastern U.S.	1 (0/1/0)
Harrelson Landing	61	Louisiana	Southeastern U.S.	1 (0/1/0)
Jones Landing*	62	Louisiana	Southeastern U.S.	2 (1/1/0)
Myatts Landing*	63	Louisiana	Southeastern U.S.	6 (3/3/0)
Sorrel Bayou Mound*	64	Louisiana	Southeastern U.S.	5 (3/2/0)
Ward Place and Bray Landing	65	Louisiana	Southeastern U.S.	15 (8/7/0)
Southeastern Maine	66	Maine	Prairie & Woodlands	13 (8/5/0)
Western Cape Cod Bay	67	Massachusetts	Prairie & Woodlands	26 (13/13/0)
Duck Flat	68	Nevada	Great Basin	1 (1/0/0)
Fishbone Cave	69	Nevada	Great Basin	1 (0/1/0)
Grimes Point	70	Nevada	Great Basin	1 (0/0/1)
Brinkerhoff Ranch (Humboldt Sink)	71	Nevada	Great Basin	4 (2/1/1)
John Dryden Cave	72	Nevada	Great Basin	2 (1/0/1)
Lovelock Cave	73	Nevada	Great Basin	1 (1/0/0)
Spirit Cave	74	Nevada	Great Basin	1 (1/0/0)
Winnemucca: Crypt, Cowbone, Chimney Caves	75	Nevada	Great Basin	7 (4/3/0)
Montague	76	New Jersey	Prairie & Woodlands	21 (10/11/0)
Chaco Canyon	77	New Mexico	U.S. Southwest	12 (5/6/1)
Chamisal	78	New Mexico	U.S. Southwest	8 (2/5/1)
Gallina Springs	79	New Mexico	U.S. Southwest	12 (7/4/1)
Hawikuh	80	New Mexico	U.S. Southwest	53 (24/39/0)
Mimbres (multiple sites)	81	New Mexico	U.S. Southwest	14 (9/5/0)
Paa-Ko	82	New Mexico	U.S. Southwest	29 (14/15/0)
Pottery Mound	83	New Mexico	U.S. Southwest	44 (25/19/0)
Pueblo Bonito	84	New Mexico	U.S. Southwest	14 (4/10/0)
Puye Cliff Dwellings	85	New Mexico	U.S. Southwest	40 (17/23/0)
Tijeras*	86	New Mexico	U.S. Southwest	5 (5/0/0)
Fort Ancient / Oregonia	87	Ohio	Prairie & Woodlands	24 (16/8/0)
Libben	88	Ohio	Prairie & Woodlands	52 (23/27/2)
Madisonville	89	Ohio	Prairie & Woodlands	41 (18/19/3)

Turner Mounds	90	Ohio	Prairie & Woodlands	4 (4/0/0)
Mobridge	91	South Dakota	Great Plains	41 (27/14/0)
Larson	92	South Dakota	Great Plains	32 (16/15/1)
Cheyenne River	93	South Dakota	Great Plains	26 (15/11/0)
Sully	94	South Dakota	Great Plains	20 (12/8/0)
Black Widow Ridge, Anton Rygh, Medicine Crow, Charles Mix*	95	South Dakota	Great Plains	7 (0/7/0)
Averbuch	96	Tennessee	Southeastern U.S.	56 (24/27/5)
Candy Creek*	97	Tennessee	Southeastern U.S.	2 (1/1/0)
Cherry	98	Tennessee	Southeastern U.S.	20 (15/5/0)
Ebenezer	99	Tennessee	Southeastern U.S.	11 (8/3/0)
Eva	100	Tennessee	Southeastern U.S.	32 (19/13/0)
Hiwassee	101	Tennessee	Southeastern U.S.	40 (20/17/3)
Ledbetter Landing*	102	Tennessee	Southeastern U.S.	17 (13/4/0)
Ledford Island	103	Tennessee	Southeastern U.S.	41 (19/21/1)
Montgomery*	104	Tennessee	Southeastern U.S.	2 (2/0/0)
Robinson*	105	Tennessee	Southeastern U.S.	6 (4/2/0)
Thompson Village	106	Tennessee	Southeastern U.S.	26 (12/11/3)
Toqua	107	Tennessee	Southeastern U.S.	37 (17/18/2)
Wilson	108	Tennessee	Southeastern U.S.	2 (2/0/0)
Caplen	109	Texas	South Texas	15 (7/7/1)
Ernest Whitte	110	Texas	South Texas	12 (7/4/1)
Fate Bell Shelter	111	Texas	South Texas	6 (2/3/1)
Horn Shelter	112	Texas	Great Plains	1 (1/0/0)
Loeve Fox	113	Texas	Great Plains	19 (12/6/1)
Scharbauer Site	114	Texas	Great Plains	1 (0/1/0)
Mitchell Ridge	115	Texas	South Texas	20 (11/9/0)
Wilson-Leonard	116	Texas	Great Plains	1 (0/1/0)
Fort Douglas*	117	Utah	Great Basin	1 (1/0/0)
Black Rock	118	Utah	Great Basin	2 (2/0/0)
Caldwell Village	119	Utah	Great Basin	7 (2/4/1)

Coombs	120	Utah	U.S. Southwest	2 (1/1/0)
Deadman's Cave*	121	Utah	Great Basin	1 (1/0/0)
Duna Leyenda	122	Utah	U.S. Southwest	6 (4/2/0)
Evans Site / Median Village / Paragonah*	123	Utah	Great Basin	7 (3/4/0)
Ferron Creek*	124	Utah	Great Basin	3 (2/1/0)
Glen Canyon	125	Utah	U.S. Southwest	60 (33/23/4)
Injun Creek	126	Utah	Great Basin	4 (3/1/0)
Polley-Secrest	127	Utah	Great Basin	8 (6/1/1)
Kennewick	128	Washington	Western Plateau	1 (1/0/0)
Bladwin*	129	British Columbia	Pacific Northwest	6 (5/1/0)
Boardwalk*	130	British Columbia	Pacific Northwest	29 (20/9/0)
Dodge Island	131	British Columbia	Pacific Northwest	6 (4/2/0)
Fort Rupert	132	British Columbia	Pacific Northwest	14 (8/5/1)
Garden Island	133	British Columbia	Pacific Northwest	9 (4/4/1)
Hammond	134	British Columbia	Pacific Northwest	6 (4/2/0)
Kamloops	135	British Columbia	Western Plateau	10 (6/3/1)
Lachane*	136	British Columbia	Pacific Northwest	12 (10/2/0)
Lillooet Valley	137	British Columbia	Western Plateau	5 (3/2/0)
Nanaimo	138	British Columbia	Pacific Northwest	11 (8/3/0)
Nimkish	139	British Columbia	Pacific Northwest	10 (6/4/0)
North Sannich	140	British Columbia	Pacific Northwest	14 (9/5/0)
Antler Plain / Souris River Mounds*	141	Manitoba	Great Plains	15 (9/3/3)
Fort Prince of Wales	142	Manitoba	Great Plains	3 (1/2/0)
Snowflake*	143	Manitoba	Great Plains	8 (5/2/1)
Stott Mound*	144	Manitoba	Great Plains	2 (2/0/0)
Chesterfield Inlet	145	Nunavut / NW Territory	Central Arctic	21 (13/7/1)
MacKenzie District	146	Nunavut / NW Territory	Central Arctic	9 (2/6/1)
Sadlermiut	147	Nunavut / NW Territory	Central Arctic	47 (23/27/4)
Donaldson	148	Ontario	Prairie & Woodlands	8 (5/3/0)
Clark Site / Point Pelee	149	Ontario	Prairie & Woodlands	3 (0/3/0)
Altar de Sacrificios	150	Guatemala	Guatemala	15 (10/5/0)

Punta Anllulla: Hacienda Ayalán	151	Ecuador	Ecuador	13 (6/7/0)
Ancón	152	Peru	Peru	51 (27/21/3)
Aramburú	153	Peru	Peru	10 (5/5/0)
Nasca sites: Agua Santa, Cahuachi, Contayo Cax, Majoro Chico, Oncongalla, Soisongo	154	Peru	Peru	25 (14/11/0)
Cerro Azul*	155	Peru	Peru	5 (2/2/1)
Cerro del Oro*	156	Peru	Peru	9 (5/3/1)
TOTAL POD SAMPLE	--	--	--	2749 (1464/1192/93)

¹ These numbers are used for easy reference in Appendix I. They reflect no statistical or analytical information.

² Site locations are listed here by current state, province, and country designations. More specific information about site locations (latitudes, longitudes, and proximate inhabited locations) are provided in Appendix I.

³ Regions are based on those designated by Fagan (2005) and shown in Figure 4.2. See “Geographic and temporal ranges” in this section.

* These sites are aggregated with geographically and temporally similar sites for within-region and between-group analyses.

variation (due to social stratification or multiple cohabiting groups from different origins), or sites due for repatriation in the near future. Many sites lack this many measurable individuals, so a maximal goal of sixteen individuals (about eight of each sex) was maintained for statistical purposes. An exception was made for early Holocene humans, for obvious reasons, and for geographically unique populations (e.g., the tropical Ayalán from Ecuador), wherein the smaller number of available skeletons was still deemed useful. It should be noted that, due to cultural differences among regions and time periods, some groups did not bury their dead in aggregated cemeteries. This is most evident in the Great Basin, where burials generally were isolated or in small groups (with the notable exception of Stillwater Marsh). In these cases, when deemed appropriate from archaeological evidence, the skeletons from these sites were combined to constitute a “sample,” though these samples were not used in intra-group analyses. Sites with few skeletons that could not be aggregated with other sites were used in inter-regional comparisons only.

In addition to the POD, skeletal measurements taken from other data sets have been included and are listed in Table 4.2a; these constitute the extended osteological data set (EOD) of 350 American skeletons. Between 2001 and 2003, I collected postcranial measurements from a diverse global human skeletal sample (the Goldman Data Set). Among these skeletons were samples from the Yaghan (Tierra del Fuego), Ketchipauan (U.S. Southwest), Santa Cruz Island (Channel Islands), and the Toba (Gran Chaco) groups, whose measurements are included in this dissertation. Only a subset of the measurements taken for the POD was obtained during data collection for the Goldman Data Set (see Table 4.5, in “Measurements,” Section 4.2), so many analyses do not incorporate skeletons from this series. Dr. Daniel Wescott (University of Missouri – Columbia) has kindly provided

measurements from North American Great Plains, a data set consisting of 1855 skeletons with at least partial measurements from limb bones. Of these, 214 skeletons are used in the EOD, selected because they provide data unavailable for measurement in the POD, have at least one complete limb from which to calculate an intra-limb index, and have enough provenience data to locate them within a county, with a subsistence category (see below), and with a known time period. Summary data and descriptions may be found in Wescott's dissertation (2001). Some of the samples he examined are the same as those in the POD. In order to prevent artificially over-representing these groups (i.e., the South Dakota Arikara), this portion of Wescott's data is not included in the EOD. Drs. Douglas Owsley (Smithsonian Institution) and Richard Jantz (University of Tennessee) have generously shared their data for the Wizard's Beach and Gordon Creek skeletons dating from the early Holocene. Measurements taken on other early Holocene skeletons were culled from the literature (Cybulski et al., 1981; Peyre, 1994). Dr. Christopher Ruff (Johns Hopkins University) has also helpfully shared data he collected from Pecos Pueblo for his dissertation (Ruff, 1981). None of these groups has the full compliment of measurements taken on the POD, and so—like the Goldman Data Set samples—are relegated to only some of the analyses. These data were added because these samples either have been repatriated or were unavailable at the time of data collection. Their use in relation to the POD is further explained in Section 4.6 (“Statistics”).

Finally, to place the variation observed in the American sample into an established human variation context, Dr. Trenton Holliday (Tulane University) has shared osteometric data collected for his dissertation (Holliday, 1995), which consists of skeletons from eastern Africa to northern Europe. Although Holliday measured skeletons which date to the

Table 4.2a. Locations sampled in the extended osteometric data set (EOD)

Sample/Site Name	Source ¹	Site Location	Region	Number measured (♂/♀/?)
Toba, Chaco Boreale	Goldman Data Set (Auerbach, 2001-2003)	Argentina	Gran Chaco	21 (16/5/0)
Ketchipauan	Goldman Data Set (Auerbach, 2001-2003)	Arizona	U.S. Southwest	12 (6/6/0)
Santa Cruz Island	Goldman Data Set (Auerbach, 2001-2003)	California	California	18 (9/9/0)
Yaghan	Goldman Data Set (Auerbach, 2001-2003)	Chile	Tierra del Fuego	21 (14/7/0)
Gore Creek (EeQw48)	Cybulski et al., 1981 [publication]	British Columbia	Western Plateau	1 (1/0/0)
Gordon Creek	Owsley and Jantz	Colorado	Great Plains	1 (0/1/0)
Wizard's Beach	Owsley and Jantz	Nevada	Great Basin	1 (1/0/0)
São Raimundo Nonato	Peyre, 1994 [publication]	Brazil	Brazil	1 (0/1/0)
Pecos Pueblo	Ruff, 1981	New Mexico	U.S. Southwest	60 (30/30/0)
Dinsmore Mound	Wescott, 2001	Kansas	Great Plains	7 (2/5/0)
Calovich (14WY7)	Wescott, 2001	Kansas	Great Plains	7 (3/4/0)
Gateway (24LN9001)	Wescott, 2001	Montana	Western Plateau	3 (1/2/0)
Linwood (25BU1)	Wescott, 2001	Nebraska	Great Plains	9 (8/1/0)
Barcal (25BU4)	Wescott, 2001	Nebraska	Great Plains	8 (3/5/0)
Ryan (25DK2A)	Wescott, 2001	Nebraska	Great Plains	6 (2/4/0)
Large Village (25DK10)	Wescott, 2001	Nebraska	Great Plains	11 (5/6/0)
Sondergaard (25HW3)	Wescott, 2001	Nebraska	Great Plains	8 (2/6/0)
Christensen (25HW8)	Wescott, 2001	Nebraska	Great Plains	7 (5/2/0)
Ponca Fort (25KX1)	Wescott, 2001	Nebraska	Great Plains	5 (4/1/0)
25MK14	Wescott, 2001	Nebraska	Great Plains	2 (1/1/0)
Huffman / Dry Lake (25MP2)	Wescott, 2001	Nebraska	Great Plains	2 (0/2/0)
Burkett (25NC1)	Wescott, 2001	Nebraska	Great Plains	6 (3/3/0)
Wright (25NC3)	Wescott, 2001	Nebraska	Great Plains	6 (4/2/0)
Wozney (25NC13)	Wescott, 2001	Nebraska	Great Plains	2 (2/0/0)
Genoa (25NC20)	Wescott, 2001	Nebraska	Great Plains	13 (5/8/0)
Clarks (25PK1)	Wescott, 2001	Nebraska	Great Plains	10 (8/2/0)
Gering (25SF10)	Wescott, 2001	Nebraska	Great Plains	2 (2/0/0)
25SX25	Wescott, 2001	Nebraska	Great Plains	1 (0/1/0)

Fish Hatchery (25SY16)	Wescott, 2001	Nebraska	Great Plains	1 (0/1/0)
Kelly Ossuary	Wescott, 2001	Nebraska	Great Plains	7 (5/2/0)
O'Hanlon (25WN6)	Wescott, 2001	Nebraska	Great Plains	5 (4/1/0)
Pike Village (25WT1)	Wescott, 2001	Nebraska	Great Plains	12 (7/5/0)
Greenshield (32OL17)	Wescott, 2001	North Dakota	Great Plains	12 (6/6/0)
Sanota Complex (32SI1, 32SI2)	Wescott, 2001	North Dakota	Great Plains	4 (3/1/0)
Late prehistoric Washita River sites	Wescott, 2001	Oklahoma	Great Plains	7 (5/2/0)
34GR5	Wescott, 2001	Oklahoma	Great Plains	2 (2/0/0)
Buncombe Creek (34MA2)	Wescott, 2001	Oklahoma	Great Plains	2 (2/0/0)
Sullivan-Carpenter (34RM668)	Wescott, 2001	Oklahoma	Great Plains	3 (3/0/0)
McLemore (34WA5)	Wescott, 2001	Oklahoma	Great Plains	16 (4/12/0)
Antelope Creek (41HC23)	Wescott, 2001	Texas	Great Plains	5 (5/0/0)
Courson B (41OC27)	Wescott, 2001	Texas	Great Plains	4 (1/3/0)
Alibates Ruin (41PT11)	Wescott, 2001	Texas	Great Plains	3 (1/2/0)
TOTAL EOD SAMPLE	--	--	--	350 (185/165/0)

¹ All data, except the measurements for Gore Creek and for São Raimundo Nonato, were provided directly from the data collectors.

Measurements I took for the Goldman Data Set were obtained using the same methods as those used to collect data for the POD. No interobserver errors can be calculated for data collected by Cybulski, Owsley & Jantz, Peyre, or Ruff, though it is assumed that their methods did not differ significantly from those I used. Interobserver error between my measurements and Wescott's are reported below in Table 4.10.

Table 4.2b. Locations sampled in the comparative osteometric data set (COD), from Holliday (1995), $n = 441$

Sample	Number measured (♂/♀/?)	Sample	Number measured (♂/♀/?)
Bohemian (1000 yBP)	39 (22/17/0)	Poundbury, England (2000 yBP)	52 (25/27/0)
Bosnian (ca. 1000 to 500 yBP)	77 (47/30/0)	Predynastic Egyptians (5000 yBP)	70 (32/38/0)
St. Étienne, France (ca. 1000 yBP)	26 (14/12/0)	Nubian (ca. 1600 yBP)	20 (13/7/0)
Eßlingen, Germany (1200 to 400 yBP)	36 (23/13/0)	Kerma, Sudan (ca. 3600 yBP)	50 (31/19/0)
Newark Bay, Scotland (ca. 1000 yBP)	25 (14/9/0)	Uganda (50 yBP) (measured by Ruff)	46 (27/19/0)

European Upper Paleolithic (ca. 20,000 yBP), only those from his “recent” human sample were chosen for use in this dissertation due to sample size. A total of 441 skeletons (248 males, 193 females) used by Holliday are included [which includes East African skeletons measured by Ruff, but does not include the Anglo-Saxon population measured by Münter (1936)]³. Only a portion of these skeletons have vertebral height measurements, which Holliday took in the dorsal margin of the centra. As anterior maximum centrum heights are used in this study, the dorsal centrum height measurements of Holliday are converted into anterior maximum heights for each vertebra using ratio values of the two measurements generated from data generously shared by Heli Maijanen and Markku Niskanen⁴. These ratios are listed at the end of Appendix III. Holliday’s data comprise a third, comparative osteometric data set (COD), listed in Table 4.2b.

Most of the humans whose skeletal remains are used in this dissertation were from groups that did not encounter Europeans or had limited contact with them. Minimal contact was used as a selection criterion to minimize the possibility of including individuals whose parents were of post-Columbian European descent. Of course, in groups that date to after 515 years ago (1492 C.E.), individuals in the sample may still have been *affected* by the Europeans. Proto-historic Arikara remains and skeletons from some sites in Louisiana and Arkansas were found with glass beads, indicating that these groups had developed trade with Europeans (or with other groups acting as trade intermediaries). There is a possibility that Europeans and members from these groups mated, but there is a low probability that any

³ See Holliday’s 1995 dissertation for further description of his recent human sample. Münter’s sample is not used because his measurement error, and therefore his methods, cannot be assessed for accuracy.

⁴ Maijanen and Niskanen (2006) measured 59 skeletons from a medieval cemetery in Westerhus, Sweden, taking both vertebral height measurements. The conversion formulae are generated for each vertebra individually (T1 through L5), and by sex; there should be no population effects resulting from differences in upper-to-lower body proportions.

skeleton used was of “mixed” ancestry given the short amount of time that had passed between European contact with these groups and the times from which burials date. Debate continues about the impact of European contagious diseases on the demography of the Americas, but there is little question that diseases carried by the first 15th and 16th century Europeans—especially smallpox, measles, and influenza—decimated populations on both American continents, including those which would not encounter European colonizers for decades or, possibly, centuries⁵ (Dobyns, 1983; Ramenofsky, 1987; Larsen and Milner, 1994; Cook, 1998). For example, the Sadlermiut are known to have been almost entirely eradicated by a disease during the winter of 1902-1903, though they had maintained almost complete isolation from Europeans (Gardiner, 2004). The implications of this latter issue are discussed below in the “Limitations” subsection.

Also note that, among the skeletons sampled are approximately ten⁶ individuals included in the POD and four in the EOD that date to the early Holocene (before 8000 yBP). Specifically, these are Kennewick, Gore Creek, Spirit Cave, Wizard’s Beach, Gordon Creek, Horn Shelter, Wilson-Leonard, Scharbauer Site, Warm Mineral Springs, Little Salt Spring, and São Raimundo Nonato (Windover Pond, though dating to 8100 yBP, is not included as it is a cemetery and generally considered part of the Archaic cultural horizon). Only four of these skeletons—Kennewick, Spirit Cave, Wizard’s Beach, and Horn Shelter—were well preserved overall, and of these only Kennewick and Spirit Cave are nearly complete and free of taphonomic change or damage. Unfortunately, the female skeletons—Gordon Creek, Wilson-Leonard, Scharbauer Site, at least one skeleton from Warm Mineral Springs, Little

⁵ Current evidence argues that the precedent for exotic infectious disease to outpace European personal contact in the Americas rarely extended beyond a few decades, and that groups living in locations closer to the initial post-Columbian European settlement were more heavily and repeatedly infected than those geographically and culturally more remote (Milner et al., 2001).

⁶ The MNI of Warm Mineral Springs remains unresolved, as do the dates of all skeletal elements from the site.

Salt Spring, and São Raimundo—are largely incomplete and highly fragmentary; São Raimundo was described (Peyre, 1994) as a fairly complete skeleton, though many of her measurements applicable to this study (see below) have not been published. More detailed descriptions of all of these skeletons may be found in Appendix I as well as in Powell (2005).

Although these rare skeletons are of special interest to questions concerning the populating of the Americas, their uniqueness prevents them from being added into most of the analyses on other samples in this dissertation (see the Statistics section at the end of this chapter). Indeed, as Jantz and Owsley (2001) argued, the variation observed in their crania alone argues against combining them into a sample; furthermore, as variation among the earliest skeletons is one of the concerns of this dissertation, treating them as a single sample would be counter-productive. Thus, the early Holocene skeletons are considered separately in analyses and are reported as a separate section in the Results (Section 6.6).

4.1.1: Geographic and temporal ranges

The POD sample consists of individuals representing most of the temporal range of the Holocene. Figure 4.1 summarizes the temporal ranges of sites from which the POD sample was obtained, organized by modern state (United States of America), province (Canada), or country (Latin America); each line represents the known temporal range for a given site (discussed in detail below). Line colors indicate general subsistence categories, which are elaborated below in the “Subsistence categories” section. Temporal ranges represented within each region are reported in Table 4.3. Regions are derived from cultural and archaeological areas as defined by Dr. Brian Fagan (2005) and widely used in studies of North American archaeology. The regions are reproduced in Figure 4.2, which is adapted from Fagan’s main figure in Table 2.2 (Fagan, 2005).

Figure 4.1. Temporal distribution of sites by state, province, or country. Each line represents a single site. Vertical lines indicate temporal groupings. Colors indicate general subsistence groups: blue, hunter-gatherer; purple, horticultural; red, agricultural.

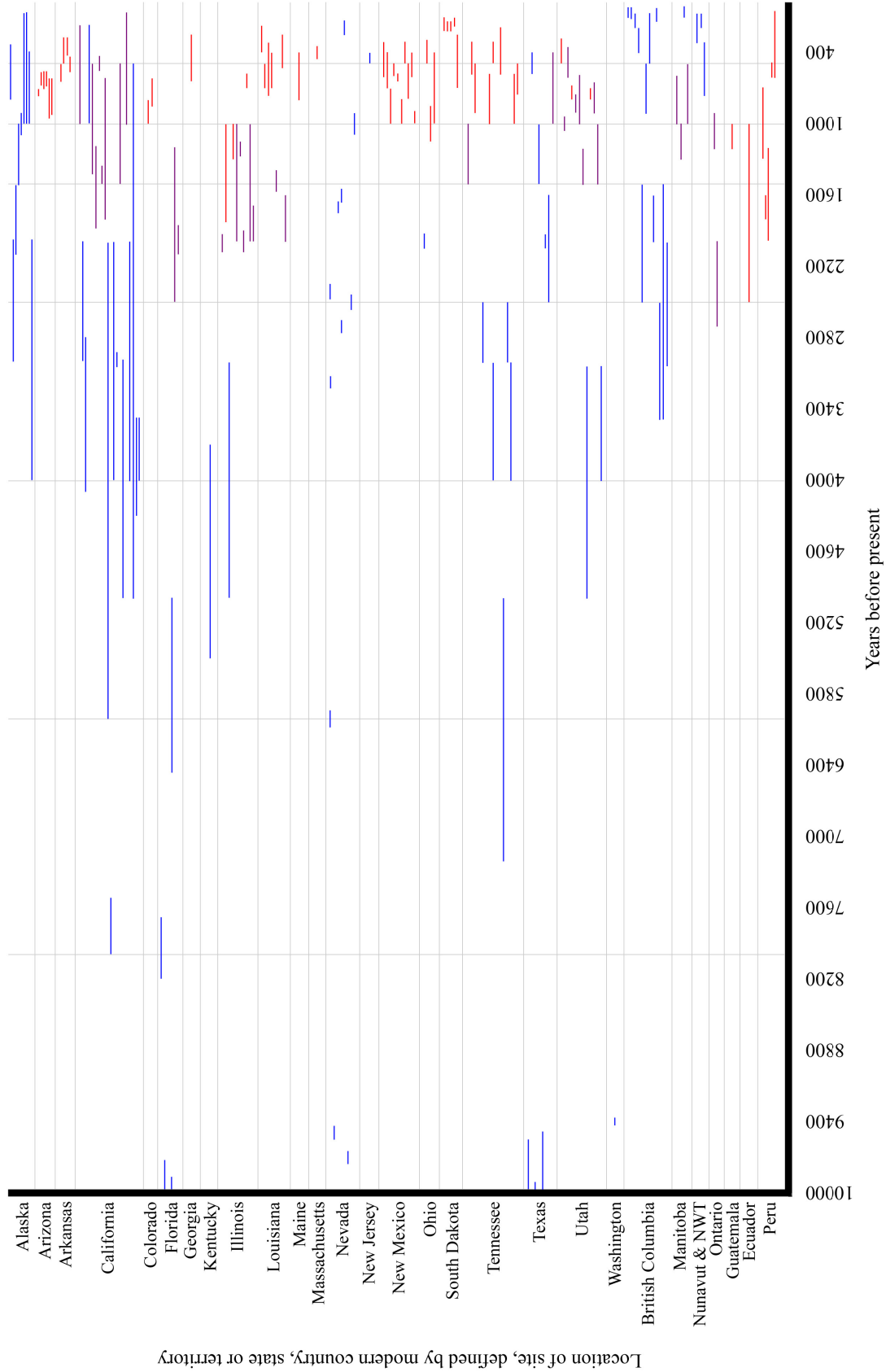


Figure 4.2. POD geographic regions used in North America (based on cultural and archaeological areas defined by Fagan, 2005) (adapted from Fagan, 2005, with permission from the author)

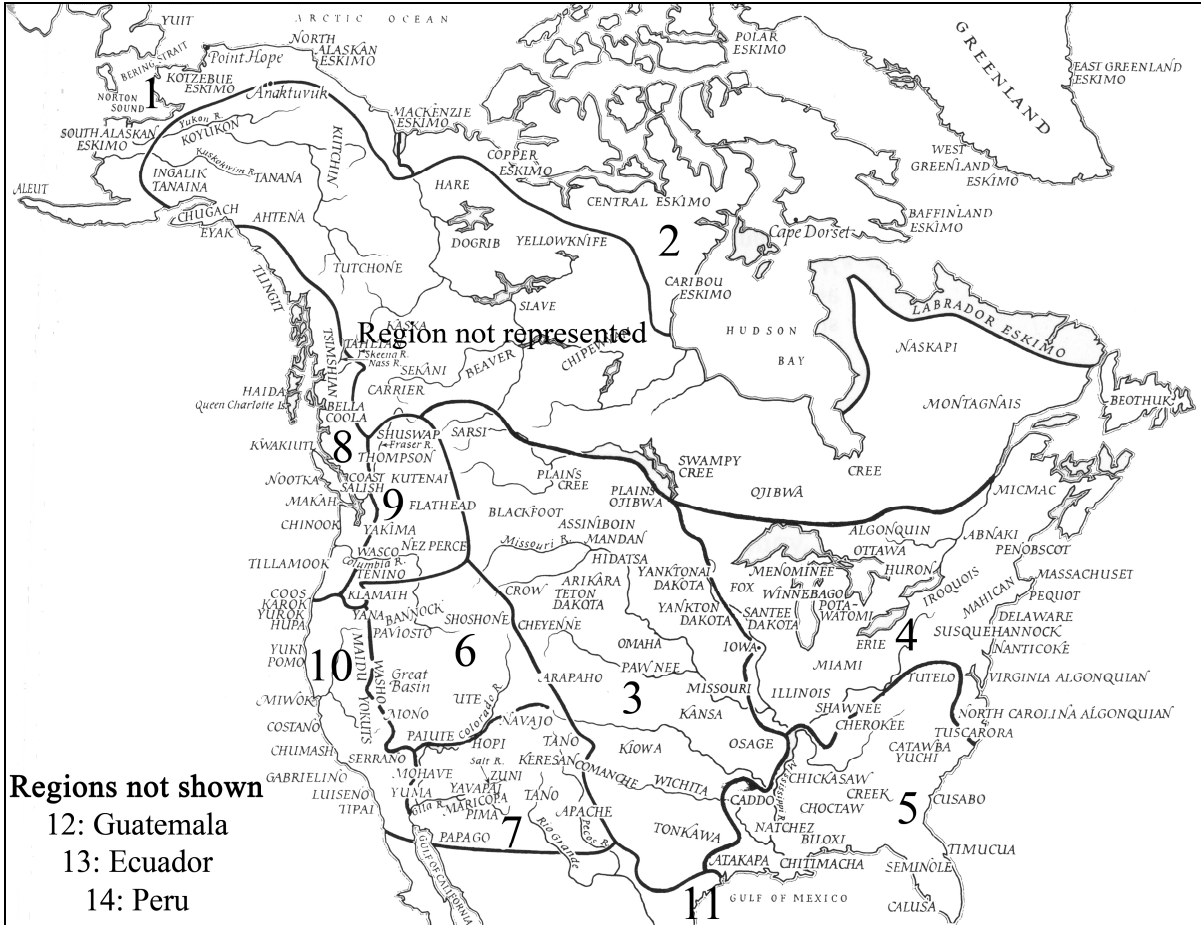


Table 4.3. Sample sizes for temporal periods by region

Region (Figure 4.2 number)	Temporal Period (yBP) ¹	POD Sample <i>n</i>	EOD Sample <i>n</i>
Western Arctic (1)	4000 – 2500	2	
	2500 – 1500	64	
	1500 – 1000	1	
	1000 – 500	222	
Central Arctic (2)	1000 – 500	20	
	500 – 50	70	
Great Plains (3)	8000 – 6000		1
	2500 – 1500		9
	1500 – 1000	10	6
	1000 – 500	56	76
	500 – 50	85	107
Prairie & Eastern Woodlands (4)	4000 – 2500	25	
	2500 – 1500	88	
	1500 – 1000	72	
	1000 – 500	90	
	500 – present	87	
Southeastern U.S. (5)	10000 – 8000 ²	4+	
	8000 – 6000	78*	
	6000 – 4000	94	
	4000 – 2500	54	
	2500 – 1500	65	
	1500 – 1000	3	
	1000 – 500	132	
	500 – present	162	
Great Basin (6)	10000 – 8000	2	1
	6000 – 4000	3	
	4000 – 2500	6	
	2500 – 1500	5	
	1500 – 1000	2	
	1000 – 500	31	
	500 – present	8	
U.S. Southwest (7)	1500 – 1000	7	
	1000 – 500	399	60
	500 – present	68	12
Pacific Northwest (8)	4000 – 2500	41	
	2500 – 1500	22	
	500 – present	55	
Western Plateau (9)	10000 – 8000	1	1
	1000 – 500	10	
	500 – present	5	3

California (10)	8000 – 6000	2	
	6000 – 4000	42	
	4000 – 2500	147	
	2500 – 1500	43	
	1500 – 1000	98	
	1000 – 500	20	18
	500 – present	27	
South Texas (11)	10000 – 8000	3	
	2500 – 1500	18	
	1500 – 1000	19	
	1000 – 500	15	
	500 – present	20	
Guatemala (12)	1500 – 1000	15	
Ecuador (13)	2500 – 1500	13	
Peru (14)	2500 – 1500	36	
	1500 – 1000	52	
	1000 – 500	5	
	500 – present	9	
Argentina (Gran Chaco) (15)	500 – present		21
Chile (Tierra del Fuego) (16)	500 – present		21
Brazil (17)	10000 – 8000		1

¹ Note that some sites, as described in this subsection, have temporal ranges that cross the temporal categorical divisions. For the purposes of this table, sites are associated with the earliest dates in their temporal ranges.

² The MNI for Warm Mineral Springs most likely exceeds 12 individuals, but only three crania were retrieved, and their temporal provenience is uncertain (see Appendix I).

* Includes the sample from Windover Pond.

As there are few sites sampled from Central and South America, each country is designated as its own “region.”⁷ This results in fourteen designated regions for the Americas in the POD; three additional regions (not shown) are added in the EOD: Gran Chaco, Tierra del Fuego, and Brazil. Regional categorization is used in analyses comparing groups within a

⁷ Only one location from Ecuador and one from Guatemala were sampled, and so it is reasonable to designate these as their own regions. Peru was occupied by multiple cultures—among which the cultural and genetic connections are still not clear—and a wide range of environments. Placing all of the sites sampled from Peru into one region does not imply archaeological relationships among these groups or environmental homogeneity, just as, for example, placing together the variety of groups occupying the U.S. Southwest does not. Within the sample used in this dissertation alone (both the POD and EOD) are representatives from the Huari Empire, Proto-Lima culture, Nasca culture, Cañete culture, and Inca Empire.

temporal period, and for patterns of morphological change over time among sites within a given region.

As an aside, it should be noted here that site locations (latitudes and longitudes) were determined as accurately as possible based on site records, field accounts, or nearby place names. More recently excavated sites are generally well-documented, with burial and site locations recorded using survey equipment, 7.5-minute maps, and, in recent years, global positioning satellite (GPS) technology⁸. Unfortunately, in the cases of skeletons recovered early in the twentieth century, researchers were often vague in their descriptions. Cross-referencing modern excavations near the sites of the original skeletal retrievals, utilizing place names noted by collectors, and examining original documents (and, if available, hand-drawn maps), all sites listed in Appendix I could be located within a few degrees of certainty using digital world mapping software (Cartografx Corporation's World Navigator Professional Edition, Version 2.59). Furthermore, archaeological affiliations of artifacts (and their known distributions) allowed for a more precise regional designation of sites and aided in the confirmation of site locations. Use of these geographic variables in analyses is described at the end of this subsection.

Regional representation across North America in the POD sample is unequal. Nearly 40% of the skeletons were recovered from sites either in the Southeastern United States (610, ~22%) or the Southwestern United States (474, ~17%). This dominance by groups from these regions is intentional. These areas were chosen for testing secular trends and change within a region, and for intraregional variation comparisons among temporally similar groups. The remainder of the POD sample is composed primarily of skeletons from

⁸ Because of the Archaeological Resources Protection Act (ARPA) in the United States, exact locations of sites cannot be divulged. All latitudes and longitudes provided in Appendix I are close to, but are not exact locations.

California (379, ~14%), the Prairie States and Eastern Woodland (362, ~13%), and the Western Arctic (289, ~11%). Skeletal remains from the Great Plains, the Great Basin, the Pacific Northwest and Plateau, and the Central Arctic are rare, due to repatriation, few recovered burial grounds, burial practices, or a combination of these factors. Skeletal samples from Mexico and Central America that include full skeletons are infrequently stored in the United States and Canada, and access to collections in Mexico—principally those in the Instituto Nacional de Antropología e Historia—has been planned for a future phase of data collection. Thus, the representation of Mayan, Mixtec, Nahuatl, Zapotec, and other Central American groups is largely missing from this analysis.

Given the geographic and temporal ranges described in Table 4.3, many archaeological traditions—especially lithic and ceramic—are present in the total sample. Traditionally, many studies examining group differences among archaeological populations rely on these material culture distinctions and not on absolute temporal divisions (e.g., Bridges, 1991; Merbs, 2001; Hermann, 2002). This is because these comparisons have often been made within circumscribed regions, where separations demarcated by cultural change are useful in testing hypotheses involving alterations in subsistence, population movement, or interactions with neighboring groups. Throughout the Americas, changes in association with these influences did not occur concurrently among regionally proximate groups. The Late Woodland culture and subsistence pattern, for example, ended at different times in the United States Southeast, northern Eastern Woodlands, and Manitoba (Fagan, 2005). In addition, comparisons among geographically dispersed regions within the same time period are made difficult due to cultural incongruence. Within some regions, such as the Southern Plains (Texas) or portions of the Great Basin, archaeological traditions and subsistence modes

remained largely unchanged for hundreds (possibly thousands) of years (Patterson, 1979), whereas the United States Southwest experienced a relatively rapid series of cultural changes (see Chapter 2 for more discussion).

In grouping sites for comparisons, then, there is little utility in using differences among groups' material culture in this dissertation, other than in discerning site homogeneity and as an aid in the aggregation of small, geographically proximate sites. This is mostly because, given the temporal and geographic range of the total sample, archaeological cultural divisions are incongruent, and therefore cannot be used to group sites into temporally similar periods across that geography. For this reason, temporal divisions, demarcated by the grey vertical lines in Figure 4.1 and listed in Table 4.3, are used instead. Temporal groups, rather than the actual estimated dates (in years before present, or yBP), are selected for group analyses to allow for the comparison of temporally proximate sites that may not have overlapped in time range, as well as to make temporal comparisons within regions easier. This is a heuristic device employed because, as noted, no cultural, migrational, or other divisions are temporally common among all human groups living in the Americas. These temporal divisions are generally determined by the density of samples from a temporal range and common endpoints to the temporal ranges of sites (e.g., if only 10 sites from three regions are present from 250 yBP to the present, whereas 50 sites from seven regions dating between 500 yBP and the present are sampled, 500 yBP is chosen as a division between temporal groupings). The seven temporal boundaries used here are 500, 1000, 1500, 2500, 4000, 6000, and 8000 yBP. Five hundred yBP is chosen as it is close to the Columbian European contact horizon. One thousand, 1500, 2500, and 4000 yBP are selected due to sample densities and common temporal demarcations for sites. The Archaic traditions

occurred generally between 8000 and 4000 yBP, which is divided at 6000 yBP due to climatic differences that exist between the early and late halves of this temporal range. Skeletal samples dating to before 8000 yBP are exceptionally rare, many being catalogued into the early Holocene “Paleoindian” period.⁹

Before discussing the practical application of these divisions in the following paragraph, the sources for site temporal ranges should be discussed further. Restrictions on destructive analysis and practical limitations did not allow for the absolute radiometric or isotopic testing of skeletons during data collection. Many sites, however, had previously undergone absolute dating (using radiocarbon dating and, more recently, accelerator mass spectrometry) from skeletal remains and/or artifacts over the last half-century. The advantage of these dates is that they provide a generally empirical source for the time period in which archaeological sites were occupied. However, a difficulty in radiocarbon-derived dates is that the dating of sites may have occurred before modern refinements allowed for better control of contamination, more precise carbon isotopic measurement, or more appropriate absolute dating techniques. Dating methods that rely less on the nominative (“relative”) dating (Colman et al., 1987) of ceramics and lithics are preferable. Nominative dating depends on subjective taxonomy and is prone to errors arising from data gaps in artifact series, inconsistent identification of a ceramic or lithic technology, incongruent development of technological changes between comparative sites, the persistence of artifacts well beyond the date of their initial manufacture, and resulting problems involved with associating these artifacts with others to develop a temporal sequence (Feathers, 1997). Therefore, the majority of sites sampled in this dissertation are cited with the complete range of reported

⁹ As noted in Chapter 2, this is a misleading term as it groups humans who may have been considerably culturally and genetically distinct, and presupposes a link between these humans and more recent “Indians.” See the “Origins” section of Chapter 2 for further discussion.

available dates (or radiocarbon dates with error terms), even though specific skeletal samples date to only a portion of that range. In the few instances in which absolute dating of sites had not been performed, I report the relative dates based on reported artifact associations with nearby, absolute dated sites, or the dates presented in site descriptions. These are indicated in Appendix I as dates followed by a parenthetical question mark. Thus, the dates used to temporally assign sites are subject to some error, although this has been minimized as much as possible with available information.

In analyses, the temporal ranges reported in Table 4.3 and shown in Figure 4.1 are used in group comparisons across geographic regions and among sites within regions. Skeletal samples were assigned to time periods based on the majority of the time period cited for the occupation of the site. For instance, the skeletons from Indian Knoll derive most likely from a period between 4800 yBP and 3700 yBP, though the bottom limit of temporal range is uncertain (Hermann, 2002). Because most of the site's skeletal sample dates to before 4000 yBP, the site was assigned to the 6000-4000 yBP time range group. Some skeletal samples, however, unquestionably cross the designated temporal divisions, but are, like Indian Knoll, examined as assigned to the earlier time period. For example, the Fort Ancient skeletal assemblage has reported dates from 1000 yBP to 400 yBP (just prior to European contact), with some uncertainty in these dates. These skeletons, however, are designated to the 1000 to 500 yBP temporal group, though some skeletons may date to the 100 years following this period, on the assumption that *most* of the individuals from Fort Ancient died in the first 500 years of the site's occupation. The statistical procedures using temporal variables in analyses are further reviewed in the following "Statistical methods" section of this chapter.

Like the geographic distribution of the skeletal sample in the POD, the temporal

distribution is unequal among all periods sampled. Over half of the total sample dates to the last millennium (1595 individuals, ~58%). This is primarily due to better preservation of more recent skeletons, easier identification of more recent habitation sites, and preferential excavation practices in regions with more recent, concentrated occupations (see the “Limitations” subsection below). In the remaining portion of the sample, most of the skeletons date to between 4000 and 1000 yBP (~33% of the total sample), with only 247 (~9%) skeletons from prior to 4000 yBP. These oldest skeletons mostly were found in six sites: Ellis Landing (California), Eva (Southeastern United States), Indian Knoll (Southeastern United States), the La Jolla sites (California), Tick Island (Southeastern United States), and Windover (Southeastern United States).

A note about the use of longitude and latitude:

In numerous previous studies, longitude and latitude have been employed in direct comparison with morphology (e.g., Stinson, 1990; Holliday, 1999). A problem with this is the inherent assumption that latitude and longitude are equivalent measurements reflecting geography. They, however, are not equivalent data; the distance between any two degrees latitude on the globe is equal, whereas the distance between any two degrees longitude changes relative to the location on the Earth.

So that longitude and latitude are comparable data, a new correction factor is applied to longitudes. As the numbers of kilometers between longitudes decrease closer to the poles, standardizing longitudes by the circumference of the Earth at their latitudes would equate these distances. (Effectively, this method changes the Earth into a cylindrical solid.) The determination of the circumference at any latitude is dependent on knowing the radius of the Earth at that latitude. This may be accomplished using basic trigonometry, as shown in

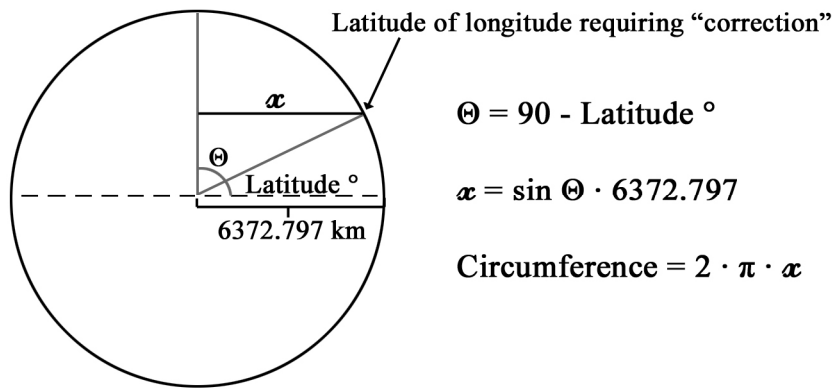


Figure 4.3. The determination of Earth’s radius (x) at any given latitude

Figure 4.3. Modeling the Earth as a sphere (not an oblate sphere, which it is in reality), and knowing that the mean radius of the planet is 6372.797 kilometers, the radius of the planet at any degree latitude is determined using the equations listed in Figure 4.3 (where Latitude[°] refers to the latitude of any given longitude needing correction). These radii are then used to compute circumference. Multiplying longitude degrees by the resultant circumferences yield longitudes that take location into account, equalizing the distance between degrees longitude. These scaled longitudes are divided by 10⁵ for convenience. For example, at twenty degrees north latitude, a longitude of 100 degrees west would be standardized by a circumference of 34,676.93 km, yielding a “corrected” (or scaled) longitude of 34.68. A longitude of 100 degrees west located at sixty degrees north latitude, however, would be standardized by a much smaller circumference—20,020.73 km—producing a “corrected” longitude of 20.02.

In addition to this correction, the shape of the Americas, and the distribution of the locations of sampled sites, latitude and corrected longitude are significantly correlated with each other ($r = -0.733, p < 0.01$). Therefore, analyses using latitude and longitude as factors (together or separately) would suffer exaggerated results in relation to these geographic

variables (i.e., they are collinear). When used in analyses, latitude and longitude are never examined simultaneously, and the statistics used control one variable for the other. This, in turn, limits the statistics that may be used taking specific geographic locations into consideration. For example, partial correlations are used in place of bivariate correlations when considering the effects of latitude or longitude¹⁰. Geographic regions (Figure 4.2) are used instead of latitude and scaled longitude for some analyses, to allow for additional statistical tests.

4.1.2: Limitations

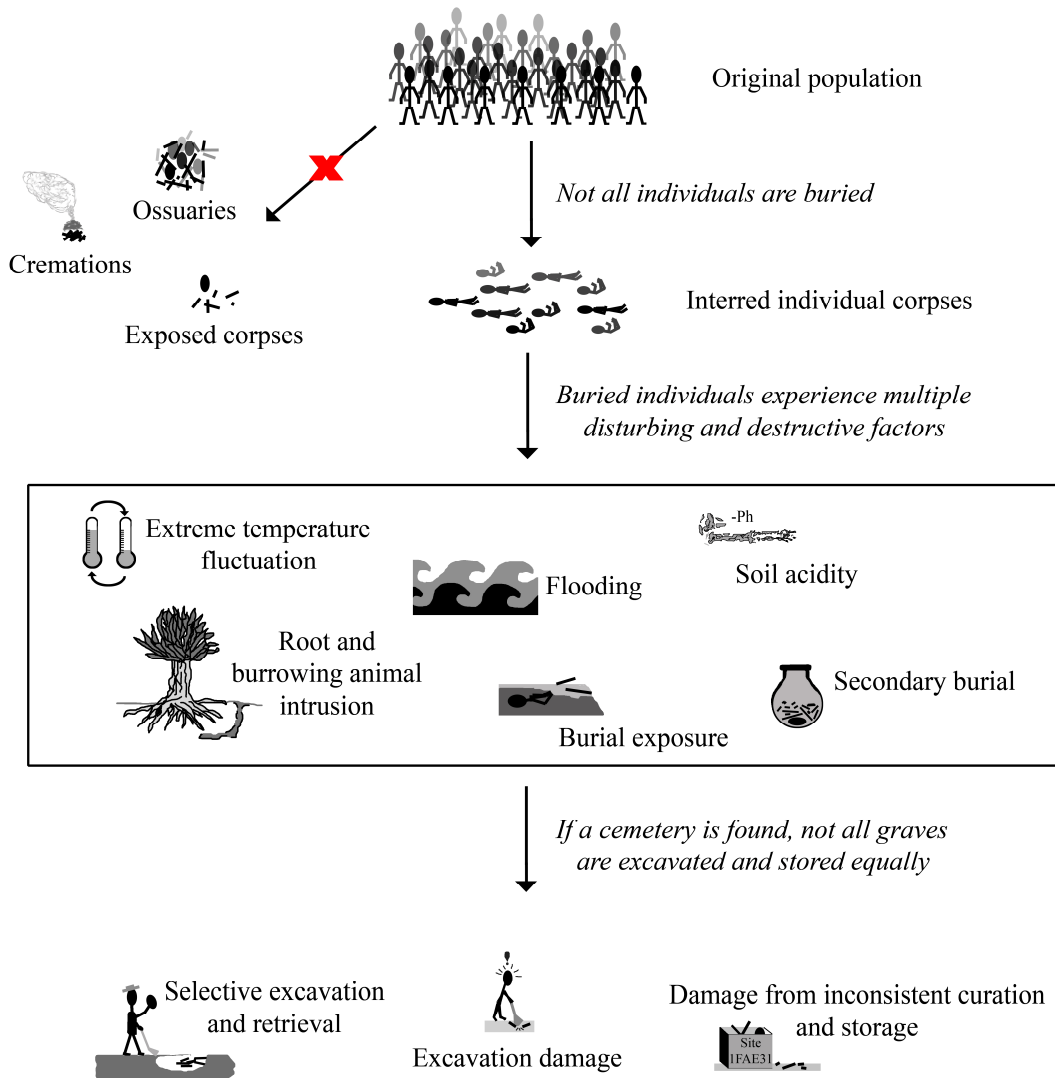
It is apparent, based on the gaps in geography and time, that there are limitations to gathering a skeletal sample representing a substantial portion of human occupation in the pre-Columbian New World.¹¹ Some of these limitations are logistical: some skeletal samples are under restricted access; large numbers of skeletons have been reburied after their recovery due to national and local repatriation laws; and the amount of time to allow for data collection is limited. Most restriction in the available sample, though, is inherent in the incomplete preservation of skeletal remains for archaeological investigation.

One could visualize the process of burial to excavation as a series of “filters” (Figure 4.4). Obviously, the nature of burial dictates the survival of human remains to modern archaeological excavation. Cultures that cremated their dead or left them fully exposed without burial are rarely represented in skeletal samples. Likewise, groups that inhumed

¹⁰ In addition, reducing geographic location to a single component (using principal components analysis) is also a viable option, though it is not employed.

¹¹ Indeed, a paradigmatic problem is that researchers still debate the demography of the Americas and the nature of human diversity in the New World prior to 1492 C.E. (Ramenofsky, 1987). Whether humans numbered in the millions or the tens of millions at the time of European colonization of the Americas is important, but cannot be addressed in this dissertation. Rather, aggregating the best possible data to represent the known, available human skeletal sample has been the goal in data collection.

Figure 4.4. Inherent sample limitations to the archaeological skeletal sample



bodies into ossuaries, thus resulting in commingling of remains, cannot be used in this study even if remains were well-preserved. These constitute an initial filter. The nature and location of the disposition of the dead composes the second filter. Corpses buried in shallow graves, in acidic environments, in geographical areas prone to flooding, in locations undergoing extreme temperature fluctuations, and experiencing a plethora of other, extrinsic

physical conditions will generally be subject to faster rates of decomposition and damage to skeletal elements (Henderson, 1987; Waldron 1987). The reburial of skeletons, intrusions into burials (with other burials, human construction activities, burrowing animals, or plant root growth), and purposeful alteration of human remains peri- and post-inhumation will produce random influences on the preservation of skeletal regions over others (Boddington, 1987). Finally, the actions of excavation and curation produce a final filter: poor digging technique, incomplete and/or selective site or skeletal excavation, water or drying damage, improper handling and transport, cleaning damage, and improper storage will influence what skeletal groups and elements are available for study (Waldron, 1987).

In addition to these factors, there are variables intrinsic to skeletal remains affecting preservation. As discussed by Galloway et al. (1996) and Stojanowksi et al. (2002), the mass of bones and their mineral densities have significant effects on their rates of degradation. Intuitively, skeletal elements with lower density and mass are present with lower frequency; cervical vertebrae survive burial less frequently than lumbar vertebrae, and femora are more often intact than most other postcranial elements. However, in addition to mineral density and mass, bone shape influences preservation (Galloway, 1996). Thinner, flatter bones (e.g., ribs) are more prone to breakage on account of their cross-sectional shape, anatomical location, and mineral density than other bones with more cylindrical shapes and thicker cortices (e.g., femora). Inherent bone properties interact with the aforementioned extrinsic factors, which amplify the differential preservation among elements (Bello et al., 2006). Together, these factors contribute to the incidence of missing skeletal elements reported by Waldron (1987), who examined the occurrence of missing elements in a Romano-British cemetery. These frequencies from his study are reported here in Table 4.4. Similar missing

Table 4.4. Missing skeletal element frequencies reported by Waldron, 1987

Element	Percent missing
Cranium ¹	83.0%
Manubrium	76.1
Clavicles ²	55.4
Cervical vertebrae	48.4
Thoracic vertebrae	42.0
Lumbar vertebrae	41.6
S1	40.9
Humeri ¹	46.6
Radii ¹	47.7
Ulnae ¹	48.6
Femora ¹	45.2
Tibiae ¹	52.3
Fibulae ¹	74.1
Tali	52.3
Calcanei	53.4

¹ This refers to completely intact crania; incomplete crania are much more common.

² A mean of the medial and lateral aspects recovered bilaterally.

element distributions are present in the POD (see Chapter 5, “Frequencies of missing elements”), with the exception of crania and limb bones. The higher presence of these is due to the bias of selection criteria for the inclusion of specimens in the POD sample.

Together, these factors create the difficulty in studies utilizing archaeological samples. Rarely are all elements preserved in a skeleton, especially in those preserved from greater antiquity. Therefore, missing data arising at the individual level are a central dilemma in the POD and EOD samples. This topic is given detailed consideration in Chapter 5. Using the protocol developed in that chapter, missing skeletal measurements are estimated where possible in the POD and employed as described below in the “Statistics” section.

In addition to these considerations for the survival of individual burials, the inherent conundrum of the archaeological sample representation of a biological population must be considered. As noted by Larsen (1997):

Human remains from archaeological sites may represent a biased portion of the population from which they were drawn, since, after all, they are cumulative aggregates usually containing multiple generations of individuals and not biological populations.... Because of the potential for biological selectivity, individuals included in archaeological skeletal series may have shortened growth velocity, elevated mortality, and elevated morbidity and sickness in comparison with the larger population (pp. 334-335).

This problem was presented as a fundamental argument in James Wood et al.'s classic "The Osteological Paradox" paper (1992), which concerned the use of archaeological samples in adequate representations of demography and pathology in past populations.

However, the issue is also relevant to this dissertation. The representation of biological continuity among the sampled population or populations at a site is crucial in the testing of the hypotheses. Within a site, population replacement by or combination with a population from another climatologically distinct region will produce misleading results. For most of the sites in the POD, though, based on similar material culture and short occupation, skeletons most likely derived from the same biological population, albeit sampled from more than one generation. However, length of occupation is not always a good indicator of how many populations occupied a site. Some sites are notable exceptions, such as Grasshopper Pueblo: occupied for less than 150 years, intra-site architectural variation indicates at least two Pueblan groups co-founded a consolidated pueblo there after abandoning their own, separate settlements (Riggs, 2001). Contrastingly, the Eva site may have been occupied for a millennium (Lewis and Lewis, 1961) by three cultures with some biological continuity (Powell, 1995). In all cases, sites have been chosen to minimize this potential shortcoming.

Skeletons from multiple groups at a site (representing multiple occupations or concurrent habitation) are separated for analyses, such as Grasshopper, when their division is known from burial locations at a site. Furthermore, in the interpretations of results from tests of intra-site variation (see the “3rd Order” in the “Statistics” section, Section 4.6.4), the potential for biased sample representation is taken into account.

Indeed, as stated at the beginning of this chapter, it is important to be aware that the limitations in sample acquisition and representation fundamentally affect the results and interpretations of this study. Some measurements of elements may be estimated from those elements that are present, but there are restrictions to the applicability of this method (see Chapter 5). Professional archaeology in the Americas has a brief history, and the systematic excavation of skeletons has only occupied a portion of that period (Fagan, 2005). The available sample is limited, and the methods for their excavation vary widely over time and across geography in the Americas. However, the POD and EOD include a representative sample of North American diversity. Despite the limitations introduced in this section, then, much can be gleaned from the metrics and derived morphologies of this large skeletal sample.

4.2: Measurements

Metric and non-metric measurements were obtained from skeletons to serve one basic function: the reconstruction of morphology. All of the osteometric measurements that were taken are useful in the estimation of body proportions (intra- and interlimb proportions, relative limb-to-torso dimensions, neurocranial and facial proportions), body size (mass and stature), bilateral directional asymmetry, and long bone robusticity. Furthermore, these osteometric measurements are generally well-defined, standardized, and highly replicable.

Non-metric observations—sex, general age estimation, and noted pathology or trauma—are essential for the accurate application of these osteometrics in the estimation of these morphologies.

4.2.1: Osteometrics

Seven craniometric measurements, fifty-two axial skeleton measurements, three pelvic measurements (two of which are bilateral), eighteen bilaterally-measured upper limb measurements¹², and nineteen bilaterally-measured lower limb measurements were taken whenever possible on skeletons included in the POD. The majority of these osteometric measurements are considered standard (Martin, 1928; Howells, 1973) or recently-revised versions of standard measurements (Fully, 1956; Raxter et al., 2006). All measurements have been given three- to four-letter abbreviations for easy reference. Some of these are the same as those used by Howells (1973) and previously by me (Auerbach and Ruff, 2004, 2006; Auerbach and Raxter, in review). These are listed in Table 4.5 with their abbreviations and described with illustrations in Appendix II. (The subset of these measurements taken in the Goldman Data Set, Dr. Daniel Wescott's data, Dr. Christopher Ruff's data, and Dr. Trenton Holliday's data are also indicated in Table 4.5.) The osteometrics were obtained using a Paleo-Tech 500 mm field osteometric board (accurate to the nearest 0.5 mm), Paleo-Tech 300 mm spreading calipers (accurate to the nearest 1 mm), and Mitutoyo 150mm digital sliding calipers (accurate to the nearest 0.01 mm), the latter of which was directly linked to a notebook computer to allow for instantaneous measurement input into a Microsoft Excel

¹² Clavicles are included as upper limb bones, though their function as intermediaries between the upper limb and the axial skeleton, as well as a distinct developmental origin (dermal versus chondral) often classifies them as separate (generally shoulder girdle) elements (e.g., see Steele and Bramblett, 1988; White, 2000). This is because the clavicle appears to function as an integrated component of the upper limb, based on correspondence of bilateral asymmetry in diaphyseal breadth (Auerbach and Raxter, in review).

Table 4.5. Osteometric measurements taken on the skeletal samples

Skeletal element	Measurement	Abbreviation
Cranium	Basion-bregma height	BBH
	Glabella-opisthocranion length	GOL
	Euryon-euryon breadth	EUB
	Prosthion-glabella height	UFH
	Rhinion-nasospinale height	NAH
	Alare-alare breadth	NAB
	Zygion-zygion breadth	ZYB
Manubrium	Interclavicular facet breadth	JNB
Clavicles ²	Clavicular maximum length ^{†§}	CML
	Clavicular 50% diaphyseal anteroposterior diameter [†]	CAPD
	Clavicular 50% diaphyseal superoinferior diameter [†]	CSID
Vertebrae	Maximum SI centra height of vertebrae C2 to L5 (or L6) [§]	XC#; XT#; XL#
	Anterior midline SI centra height of vertebrae C2 to L5 (or L6)	MAC#; MAT#; MAL#
	C2 height without dens	C2a
	Maximum SI height of S1	XS1
	Maximum sagittal SI height of the sacrum [§]	SML
Humeri ²	Maximum humeral length ^{*†‡§}	HML
	SI humeral head diameter ^{*†‡}	HHD
	Humeral 50% diaphyseal mediolateral diameter [*]	HMLD
	Humeral 50% diaphyseal anteroposterior diameter [*]	HAPD
	Maximum humeral epicondylar mediolateral breadth ^{*†‡}	HEB
	Humeral capitulum-trochlea mediolateral breadth	HAB
Radii ¹	Maximum radial length ^{*†‡§}	RML
	Radial 50% diaphyseal mediolateral diameter ^{*‡}	RMLD
	Radial 50% diaphyseal anteroposterior diameter ^{*‡}	RAPD
	Radial head mediolateral diameter	RMLH
	Radial head anteroposterior diameter [‡]	RAPH
	Distal radial articular surface mediolateral breadth	RAB
Ulnae ²	Ulnar maximum length ^{†‡}	UML
	Ulnar 50% diaphyseal mediolateral diameter [‡]	UMLD
	Ulnar 50% diaphyseal anteroposterior diameter [‡]	UAPD

Femora ²	Femoral maximum length* ^{†‡}	FML
	Femoral bicondylar (physiological) length* ^{†§}	FBL
	Femoral head anteroposterior diameter* ^{†‡}	FHD
	Femoral 50% diaphyseal mediolateral diameter* ^{†‡}	FMLD
	Femoral 50% diaphyseal anteroposterior diameter* ^{†‡}	FAPD
	Femoral epicondylar breadth* ^{†‡}	FEB
	Femoral distal articular (bicondylar) mediolateral breadth*	FAB
Tibiae ²	Tibial maximum length* ^{‡§}	TML
	Tibial “Fully technique” length [†]	TFL
	Tibial plateau mediolateral (bicondylar) breadth* [‡]	TPB
	Tibial proximal articular mediolateral breadth	TPAB
	Tibial 50% diaphyseal mediolateral diameter* [‡]	TMLD
	Tibial 50% diaphyseal anteroposterior diameter* [‡]	TAPD
	Tibial distal articular surface mediolateral breadth	TDML
	Tibial distal articular surface midpoint anteroposterior breadth	TDAP
	Tibial distal articular surface maximum anteroposterior breadth	TDAX
Fibulae ²	Fibular maximum length [†]	FIML
Os coxae	Bi-iliac breadth* ^{‡§}	BIB
	Maximum iliac blade length ^{2*}	IBL
	Maximum acetabular height ^{2*}	ACH
Tarsals ²	Talus-calcaneus height	TCH
	Talar trochlea anteroposterior midpoint breadth	TTB

¹ UFH, NAH, NAB, JNB, diaphyseal diameter, vertebral heights, articular breadth (excluding epiphyseal breadths: HEB, FEB, and TPB) measurements are taken to the nearest 1/100th millimeter. Maximum long bone lengths, epiphyseal breadths, BIB, and TCH are measured to the nearest ½ millimeter. The remaining craniometrics and IBL are measured to the nearest millimeter.

² Measured bilaterally when available

* Measurement in the Goldman Data Set

[†] Measurement taken by Wescott (2001)

[‡] Measurement taken by Ruff (1981) (FHD measured SI, converted using formula developed by Ruff)

[§] Measurement taken by Holliday (1995) (dorsal heights taken on vertebrae, converted to maximum heights using formulae developed from data shared by Maijanen & Niskanen)

2003 spreadsheet. Measurements taken using the osteometric board and the spreading calipers were manually input into the spreadsheet at the time of measurement.

Some measurements are newly defined or revised for the data collected in the POD. The interclavicular facet breadth on the manubrium (JNB), which approximates the minimum distance between the medial heads of the clavicles, is a newly-defined measurement. Likewise, the tibial distal articular surface maximum anteroposterior breadth is newly defined, in an effort to better model the distal articular surface as a trapezoid, rather than as a square. The vertebral measurements are either recently revised (Raxter et al., 2006) or have been modified from existing measurements (Martin, 1928). Maximum acetabular height has also been modified for this dissertation, in order to make the measurement more precise. Although they have not been standardized in osteometric reference manuals (e.g., Martin, 1928; Montagu, 1960; Buikstra and Ubelaker, 1994), the ulnar and tibial 50% diaphyseal diameter measurements are not unique to this dissertation (e.g., Ruff, 2002b). These last measurements were chosen over more commonly used measurements (i.e., diameter of the ulnar diaphysis at the maximum crest and tibial diaphyseal diameter at the nutrient foramen) to standardize the location of the measurement to be mechanically equivalent among all individuals measured, as well as to maintain similitude with the other diaphyseal measurements taken.

The measurement errors for the measured dimensions are listed in Table 4.6 as percentages and values in millimeters. These are derived from three sets of measurement trials taken on 20 Hawikuh skeletons and on 10 Terry Collection skeletons (NMNH – Smithsonian). Measurement errors were calculated by determining the average difference of each measurement—taken from the three trials—from their mean, and then dividing that

Table 4.6. Measurement errors for measurements taken in the POD

Element	Measure ¹	% Measurement Error ²
Cranium	BBH	0.06 %
	GOL	0.67
	EUB	0.22
	UFH	0.85
	NAH	1.33
	NAB	0.44
	ZYB	0.17
Manubrium	JNB	1.21
Clavicle	CML	0.08
	CAPD	0.73
	CSID	0.96
Vertebrae	XC#; XT#; XL# MAC#; MAT#; MAL#	Mean error: 0.54 Mean error: 0.54
	XS1	0.50
	SML	0.09
	Humerus	HML
Humerus	HHD	0.34
	HAPD	1.12
	HMLD	1.99
	HEB	0.41
	HAB	1.03
	Radius	RML
Radius	RAPD	1.16
	RMLD	0.75
	RMLH	0.79
	RAPH	0.65
	RAB	1.47
	Uln	UML
Uln	UAPD	0.76
	UMLD	0.66
	Femur	FML
Femur	FBL	0.15
	FHD	0.15
	FAPD	0.34
	FMLD	0.54
	FEB	0.31
	FAB	0.84
	Tibia	TML
Tibia	TFL	0.13
	TPB	1.80
	TAB	0.47
	TAPD	1.77
	TMLD	1.92
	TDA (mean of three measurements)	1.24
Fibula	FIML	0.10
Os coxae	BIB	0.31
	IBL	0.28
	ACH	0.62
Tarsals	TCH	0.52
	TTB	0.65

¹ See Table 4.5 for abbreviation meanings.² Average difference of three measurement trials from their mean, divided by the mean and multiplied by 100 (White, 2000)

difference by the mean and multiplying the result by 100 (after White, 2000). In general, measurement errors indicate reliable replication of the majority of the dimensions, with errors under 1%. The highest measurement error occurred in tibial diaphyseal measurements (nearly 2%), likely due to the slight variation in determining the orientation of the tibia relative to the anteroposterior and mediolateral planes, which were based on the mediolateral orientation of the tibial plateau (see Figure A12c, Appendix II). The plateau and distal tibial articular breadths have similarly high measurement errors (~1.8%), though none of these are deemed so large as to make any of the dimensions unusable. These amounts of measurement error are useful in the calculation of estimations for missing values in Chapter 5, and could be used in determining whether significant differences or similarities are potentially biologically meaningful or if they are more likely the result of random “noise.”

Means for each measurement, listed by sex and by sample, are given in Appendix V, Part A. Derived morphology means—calculated body size, shape and proportions—are likewise presented in this appendix (Part B). The means for the derived morphologies are also given for the earliest Holocene samples (from 10,000 yBP to 8000 yBP) in the final part of Appendix V (Part C).

4.2.2: Non-metric data

In addition to metric measurements, some non-metric data were collected on skeletons. When notable pathologies and trauma were encountered, these were recorded and taken into account when measurements were taken. Diaphyseal breadth measurements, for example, were not taken on individual skeletons with periostitis or osteomyelitic reactions on the periosteal surfaces of long bone diaphyses at the location of measurement. Photographs were also taken to document pathologies that were hard to diagnose at the time of observation, or

of rare disorders.¹³ Principally, however, two non-metric types of observations were taken: features related to age and sex estimation.

Individual age determination in an archaeological sample is notoriously difficult—especially in older individuals—and subject to interobserver discrepancies (see, e.g., Lovejoy et al., 1985; Meindl et al., 1985a; Isçan, 1989; Schmitt, 2004). The use of multiple indicators, as suggested by Lovejoy et al. (1985), was chosen as the method for aging individuals. However, the principal component weighting method used by Lovejoy and colleagues was not employed. Rather, the method used for aging skeletons in the POD relies more on postcranial indicators than cranial traits. Using dental attrition as an age marker is unreliable and was not employed, as it is dependent on individual behavior within an unknown range of variation within a population, and therefore consistently requires large skeletal samples for accurate application (*contra* Lovejoy et al., 1985). Age estimation based on ecto- and endocranial suture closure, likewise, has potentially high rates of inaccuracy arising from sexual dimorphism and population-specific variation (Key et al., 1994), as well as precluding reasonable estimation of age for individuals at the extremes of adult ages (Saunders et al., 1992). Thus, age estimation based on cranial suture fusion was used only if postcranial indicators were highly ambiguous or unobservable. In the postcranium, pubic symphyseal morphological changes were used as the primary indicator for assessing ages,

¹³ Parenthetically, it is noteworthy that some pathologies and traumas were somewhat common, though their incidence varied among populations. For example, spondylolysis and spondylolisthesis occurred with higher frequencies in high latitude groups, such as the Sadlermiut, Tigara, and Ipiutak, as well as some lower-latitude populations, such as the Mississippian-period humans from the Dickson Mound and Averbuch Sites, and the Coalescent Period Arikara buried at the Larson site. Conversely, rare individual pathologies were also noted, including: Klippel-Feil Syndrome in a male skeleton from Hiwassee Island (Frank H. McClung Museum skeleton #93); possible rickets in a Middle Woodland Hopewellian female skeleton buried in Jersey County, Illinois (National Museum of Natural History skeleton #379955); metastasized cancer (lytic lesions) in an old adult male buried on San Nicholas Island, California (San Diego Museum of Man skeleton #17683); and signs of prolonged disuse of limbs (possibly from nerve damage) by a Kwakiutl female buried near Nimpkish, Vancouver Island (American Museum of Natural History skeleton #99.3742).

using the Suchey-Brooks system (Suchey et al., 1986; White, 2000). This system for aging has been shown to lose accuracy in estimating the ages of older individuals (Sakaue, 2006), namely those documented as older than 40 years. However, Sakaue (2006) also demonstrated that the pattern of metamorphosis of pubic symphyseal shape was widely applicable to aging skeletons outside of the Euroamerican sample on which it had been developed. In addition to the pubic symphysis, iliac auricular surfaces were observed using Buckberry and Chamberlain (2002) revisions to the Lovejoy et al. (1985) original method (see also Buikstra and Ubelaker, 1994). More reliance was placed on the morphology of the public symphysis. This emphasis has been justified by a call for further age categorization refinement of the auricular surface aging method (Falys et al., 2006). Finally, the complete fusion of vertebral centra rims and medial clavicular epiphyses were examined, as these are among the last bones to complete primary growth. Observing these characters, individuals were aged as follows: 19–22, 23–25, 26–30, 31–40, 41–50, and 50+. The two lower age categories were seriated using the appearance of the pubic symphysis and the degree of fusion of vertebral centra.¹⁴ The remaining categories were assigned based on a combination of os coxae traits and, occasionally, cranial suture closure. As ages over 50 are difficult to assign, all individuals over this age were lumped into a single category. Table 4.7 summarizes the age distribution of the overall POD sample and the POD sample by sex, overall and regionally.

Given the inherent uncertainty in their accuracy, estimated ages are not used as a significant factor in analyses. Age categories are essential only for the calculation of living

¹⁴ As noted in the selection criteria, individuals without fused long bone epiphyses (with the exception of the clavicle, as fusion may occur as late as age 30) were not included in the sample. Clavicles that lacked fusing medial epiphyses were not measured. Likewise, vertebrae missing fused centra epiphyses were not measured.

Table 4.7. Age distribution of the POD sample (overall/male/female)

Region	19–22	23–25	26–30	31–40	41–50	50+
Western Arctic	3/2/1	4/1/3	42/26/16	112/76/46	102/44/58	26/7/19
Central Arctic	2/2/0	3/1/2	22/7/15	41/23/18	19/8/11	3/1/2
Great Plains	7/4/3	4/0/4	31/12/19	64/40/24	38/27/11	7/3/4
Prairie & Eastern Woodlands	5/2/3	10/4/6	86/51/35	171/91/80	77/42/35	13/5/8
Southeastern U.S.	20/5/15	20/3/17	142/59/83	285/161/124	120/76/44	23/10/13
Great Basin	3/2/1	3/2/1	11/7/4	19/12/7	12/7/5	4/1/3
U.S. Southwest	4/0/4	26/9/17	111/57/64	206/112/94	104/56/48	21/5/16
Pacific Northwest	2/1/1	4/1/3	16/12/4	50/33/17	37/26/11	9/5/4
Western Plateau	1/1/0	1/0/1	2/2/0	5/3/2	7/4/3	0/0/0
California	8/4/4	25/9/16	93/59/34	158/86/72	78/38/50	17/7/10
South Texas	3/2/1	6/1/6	14/11/3	35/19/16	15/6/9	1/1/0
Guatemala	0/0/0	0/0/0	13/8/5	1/1/0	1/1/0	0/0/0
Ecuador	0/0/0	0/0/0	2/1/1	9/3/6	2/2/0	0/0/0
Peru	0/0/0	2/0/2	23/12/11	34/23/11	30/13/17	11/5/6
Overall sample	58/25/33	108/31/77	608/324/284	1190/683/507	641/349/292	135/50/85

stature from skeletal stature (see below) (Raxter et al., 2006; Raxter et al., 2007). In addition, age comparisons could be used as a factor in analyses that examine relative trunk length and stature, as vertebral column length is subject to decreases as a result of aging, though there are few skeletons aged over 50 years, so this factor is not considered.

Unlike age estimation, sex estimation in the POD has greater certainty, and is an essential factor in the analyses of this dissertation (see the hypotheses in Chapter 3 and below in the “Statistics” section of this chapter). Pelvic traits were favored over cranial traits, as noted by Meindl et al. (1985b), and later supported by Walrath et al. (2004), sex assignment of skeletons based on cranial non-metric characters is prone to high amounts of subjective observer error, and many of the characters (such as the size of the mastoid)—while sexually dimorphic—may be confounded by the influence of mechanical forces. In general, the methods of Phenice (1969) were used as a guideline for sexing. However, in some groups from the Americas (especially those from high latitudes), males and females both have robust, wide pelves that make the application of Phenice’s (1969) methods subject to incorrect sexing results. For this reason, the suggested refinement of those methods by Bruzek (2002) was chosen as a more precise guide for sexing skeletons; this method relies on a combination of visual assessments of five factors in assigning sex. Four of these were used for sexing individuals for the POD: greater sciatic notch contour and proportions; the composite arch outline of the sciatic notch and the superoanterior outline of the auricular surface; the shape of the ishiopubic ramus; and the relation of the pubis and ischium lengths (which could also be observed as the subpubic angle). Skeletons were classified as “male,” “male (?),” “female (?),” and “female.” Individuals with unclassifiable sex were not included in the sample. The “(?)” skeletons were determined because their pelvic traits were

somewhat ambiguous and could not be refined by examining crania or comparative bone size within a sample. For the purposes of analysis, however, male (?) skeletons ($n = 40$) and female (?) skeletons ($n = 45$) are assigned as male and female, respectively, as few skeletons were in these categories, relative to the total sample.

Sex is used as a factor in all analyses; sexual differences are important areas of inquiry for examining variation among the groups living in the Americas. For example, as discussed in Chapter 3, the amount of sexual dimorphism in mass, proportions and stature compared among populations may be an indicator of population stress and/or malnutrition (e.g., Stini, 1974). Sexual dimorphism of body proportions may also present clinal patterns in response to climatic factors. Furthermore, sex designations are important in the calculation of some of the derived morphologies (e.g., body mass from bi-iliac breadth and stature).

4.3: Derived morphologies

The osteometric measurements summarized in Table 4.5 and detailed in Appendix II are used to calculate morphological characteristics for individuals, such as body mass, stature and proportions. These are collectively referred to as “derived morphologies” throughout this study, divided into three groups: those which require only cranial dimensions for derivation, those requiring only postcranial dimensions, and those that use both cranial and postcranial dimensions. Derived morphologies are the primary factors examined against climatological, subsistence, and geographical factors, and therefore the hypotheses outlined in Chapter 3. Their calculation and use are summarized in this section, with formulae and references detailed in Appendix III.

4.3.1: Cranial

Five derived morphological characteristics are calculated for the cranium. These represent the shape of the calotte, the size of the calvaria¹⁵, and the proportions (and therein shape) of the upper face and nasal aperture. Individuals with cranial deformation are excluded from these derived morphologies; their calvaria shape has been altered, and therefore will not properly reflect natural variation. In addition, recent analysis has indicated that cranial deformation may have a significant effect on dimensions and proportions of the upper face (Rhode and Arriaza, 2006), despite low levels of developmental integration between the calvaria and the face in hominids (Polanski and Franciscus, 2006).

The shape of the calotte is modeled using the cranial index, which is the proportion of maximum width (EUB) to maximum length (GOL) of the calotte (Beals, 1972). This is similar to cephalic index in the anthropometric literature. Although this measurement does not take actual circumferential shape into consideration, it provides a scale-free method for comparing the “roundness” of the calvaria in the transverse plane, and is used in this study. “Size” of the calvaria has traditionally been examined using three methods. First, the rough transverse area of the cranium, viewed superiorly, may be modeled as an ellipse (even though the calotte is better described as ovoid):

$$\left(\pi \times \frac{EUB}{2} \times \frac{GOL}{2} \right)^2 \quad \text{[Equation 4.1]}$$

This is similar to the method used by Beals (1972) ($EUB \times GOL$), but approximates the

¹⁵ The calotte, as used herein, is the superior portion of the calvaria, which is the cranium without the bones of the face or mandible (i.e., the neurocranium).

shape of the calotte. A second approach involves calculating the volume of the calvaria as an ellipsoid, adapted from Rheinbold et al.'s (1985) method (which models the calvaria as a rectangular solid):

$$\frac{4}{3} \pi \times \left(\frac{EUB}{2} \times \frac{GOL}{2} \times \frac{BBH}{2} \right) \text{ [Equation 4.2]}$$

Finally, a third method derives the cranial “module,” which approximates the mean diameter of the calvaria and closely approximates cranial capacity (Hrdlička, 1925; Beals et al., 1984):

$$(EUB \times GOL \times BBH) \div 3 \text{ [Equation 4.3]}$$

All of the three methods combined have the benefit of representing aspects of cranial size in two and three dimensions. Given their use of the same dimensions for calculation, it is not surprising that these three models have high correlations ($r > 0.88$); therefore, the use of all three is redundant. Many anthropometric studies employ the EUB and GOL dimensions (BBH is much more difficult to observe in living humans), so the method described in Equation 4.1 is used here. Beals et al. (1984) demonstrated that cranial module (Equation 4.3) variation has a good correlation with latitude (see Chapter 3). It is preferred over cranial volume (Equation 4.2), which has a very high correlation with cranial module ($r = 0.99$, due to the use of identical components), has not been tested as extensively with geographic or climatic variables, and is difficult to compare with anthropometric-derived morphologies. Thus, cranial module is being included in this study as a proxy for cranial volume.

Facial and nasal aperture shapes are both modeled as proportions. Facial index ($ZYB \div UFH \times 100$) is among the longest-used cranial indices in modern biological anthropology (Cameron, 1929; Crognier, 1981), and indicates relative facial breadth to upper facial height.

This has some potential correspondence to both climatic and subsistence factors. Nasal index ($\text{NAB} \div \text{NAH} \times 100$) (Montagu, 1960), likewise, has a lengthy history in anthropological cranial studies, and a relationship of nasal aperture size and shape with climatic and subsistence factors—though contested (e.g., Churchill et al., 2004)—may exist (again, see Chapter 3). As these two derived morphologies are scale-free, they are directly comparable to cranial index, and all three are examined for the relative contributions of variance in their component dimensions using coefficients of variation (see the “2nd Order Statistics,” Section 4.6.3, below).

4.3.2: Postcranial

Nine postcranial derived morphologies are used in the analyses. Two of these—relative torso height and body mass—are calculated using two methods, one involving only postcranial elements, and another requiring the inclusion of the cranium, as these dimensions are whole-body morphologies. The remaining morphologies describe characteristics only of the postcranium.

Two derived morphologies are used to describe the breadth of the torso. The mediolateral breadth of the upper torso, which may relate to altitude and latitude (Weinstein, 2001, 2005), is difficult to reconstruct from skeletal elements. This is because, although the necessary elements are preserved (manubrium and clavicles), the angle of the clavicles relative to the transverse plane of the torso cannot be determined from skeletal features alone, and their relative positions are variable. Holliday (1995) and Weinstein (2001) attempted to examine upper body breadth by comparing the maximum lengths of the clavicles alone, but found that they were poor proxies. In this study, an approximation is used by adding the maximum lengths of the left and right clavicles (CML) to the interclavicular facet breadth of

the manubrium (JNB). It is acknowledged that this measurement only reflects the maximum *potential* breadth of the upper body, and is not a good approximation of the actual breadth (Churchill, 1994). That is, humans with anteroposteriorly “deeper” torsos will potentially have longer clavicles than humans with “shallower” torsos, but not because the upper body is wider¹⁶. Conversely, the width of the base of the torso is more accurately modeled, using the reconstructed bi-iliac breadth (BIB) (see Appendix II for a description). Skeletal BIB is close to living pelvic maximum breadth in lean humans, and so is used in analyses. A simple soft tissue correction factor $[(BIB \times 1.17) - 3.0]$, which was developed by Ruff et al. (1997), yields a good approximation of living pelvic breadth, and is used in body mass estimation (see Section 4.3.3).

The relative height of the torso to the length of the lower limbs was modeled by Holliday & Trinkaus (1991) and Franciscus & Holliday (1992), and further employed by Holliday in his dissertation (1995). In their method, the combined *dorsal* heights of T1 through L5, added to the ventral height of the sacrum, were divided by the length of the lower limb (FBL and TML) to generate a proportion. The summation of vertebral and sacral heights was designed to approximate the length of the living individual’s torso from the shoulders to the base of the spine (effectively, sitting height without the head and neck). Holliday, Trinkaus, and Franciscus agreed that the intervertebral discs, though contributing to overall torso length, likely did not significantly differ among living individuals and therefore could be overlooked in calculations. Recent analyses concerning the estimation of stature from skeletons with known cadaveric statures has borne this hypothesis out among modern United States whites and blacks (Raxter et al., 2006).

¹⁶ The maximum anteroposterior depth of the torso is not modeled in this study, as it requires intact ribs (which are rare in archaeological samples) and an accurate estimation of the shape of the rib cage (made difficult by a lack of costal cartilage).

Using the same logic as the Holliday et al. method, a modified version has been developed for this dissertation, summarized in the following equation (where XVH is maximum vertebral height, FBL is bilaterally averaged femoral bicondylar length, and TFL is bilaterally averaged tibial “Fully” physiological length):

$$\text{Relative torso height} = \frac{\sum_{T1 \rightarrow L5} XVH}{FBL + TFL} \text{ [Equation 4.4]}$$

This equation differs in that it incorporates the maximum anterior vertebral heights (see Appendix II), does not include the length of the sacrum, and utilizes the “Fully” physiological length of the tibia. The combination of maximum anterior vertebral heights is used to estimate stature (see below and Raxter et al., 2006), and was shown by Raxter et al. (2006) to be good estimators of vertebral length. For consistency of osteometrics used throughout the analyses, these were chosen over dorsal heights, which, additionally, may be influenced by the pedicles. Sacral maximum ventral length (SML) is preserved in only approximately half of the POD sample, is not accurately predicted from any other skeletal elements (including S1, $r = 0.36$), and variably overlaps distally with the proximal end of the femora, thereby potentially overestimating the length of the torso. For these reasons, it is not used in Equation 4.4¹⁷. This may result in a slight underestimation of torso height, but the resulting bias should be close to systematic (assuming that L5 is located in an anatomically similar position among individuals). Finally, the maximum tibial length (TML) is not used in Equation 4.4, as the intercondylar eminence overlaps with the inferior aspect of the femoral

¹⁷ Raxter et al. (2006) demonstrated that the femoral head generally is located close to the base of S2 at its most superior aspect, based on the location of the acetabulum. An unknown amount of variation in this location exists, and the ability to observe the height of S1 and S2 was also uncommon among the POD skeletons due to damage or taphonomic loss. The measurement was not taken for this reason.

condyles, therefore resulting in an overestimation of lower limb length by their inclusion. A more anatomically conservative, alternative method, described in the following subsection, has been devised for describing the relative length of the torso to the lower limbs, but is not used in analyses for this study.

The method for determining torso height used in Equation 4.4 is also used to examine the averaged relative length of the upper limbs to the torso: $(HML + RML) \div \text{torso length}$. This method is based on anthropometric observations aggregated by Eveleth and Tanner (1976) and others (Hiernaux, 1968; Susanne, 1977). As discussed in Chapter 3, the relative length of the limbs (both upper and lower) may be related to changes in both climate (e.g., Holliday, 1995) and subsistence (e.g., Takamura et al., 1988).

In addition to the derived morphologies using reconstructed torso height, three proportional relationships within and among limbs are examined. Brachial ($RML \div HML$) and crural ($TML \div FBL$) indices are calculated according to their standard formulae (although TFL would be a more accurate approximation of living leg length, the convention has been to use TML). Also, an intermembral index (e.g., Porter, 1999) is calculated as $(RML + HML) \div (TFL + FBL)$. As this involves the addition of the lower limb elements to estimate lower limb length, TFL was chosen over TML to prevent overestimation of the lower limb *sans* foot.

In an effort to examine differences in activity levels among populations, diaphyseal diameters were measured on all of the long bones in two planes (generally, anteroposterior and mediolateral, with the exception of the clavicles, which were measured superoinferiorly). These two diameters are averaged for the majority of analyses in this dissertation. Without knowledge of cortical areas, these comparisons are only suggestive of differences in bone

strength and activity levels (Auerbach and Ruff, 2006). True cross-sectional properties cannot be calculated from the diaphyseal diameters alone; the use of external dimensions of diaphyses to estimate cross-sectional mechanical properties of bones in ellipse models has been demonstrated to be unreliable, often overestimating true mechanical properties (O'Neill and Ruff, 2004). Thus, even total area, using an ellipse model, is not estimated among samples in the POD. However, the examination of bilateral asymmetry (see “Statistics” below) takes advantage of average diaphyseal diameters. Also, dividing the bilateral mean of average diaphyseal diameters by the average length of the element concerned, accounting for body size, provides a useful measure by which to compare relative diaphyseal diameter sizes among individuals within and among groups (Wescott, 2001).

One additional postcranial dimension is used alone for estimating a derived morphology: the diameter of the femoral head. As described by Ruff et al. (1991), McHenry (1992), and Grine et al. (1995), and reviewed by Ruff et al. (1997) and Auerbach and Ruff (2004), the femoral head is a useful skeletal dimension with which to estimate body mass. The efficacy of this method is due to the mechanics of the femoral head in supporting body mass. Also, as developed by Ruff et al. (1997), and reviewed by Auerbach & Ruff (2004) and Ruff et al. (2005), another “morphometric” method that combines stature and body breadth is a good estimator of body mass. Further discussion of the use of the femoral head (“mechanical” method) versus the morphometric method, as well as which femoral head equations were used in this study, is delayed until the morphometric method for estimating body mass is explained in more detail in the following subsection.

4.3.3: Cranial and postcranial combined

Three derived morphologies combine cranial and postcranial measurements: the

estimation of stature, an alternative method for estimating relative torso height, and the morphometric method for estimating body mass. As implied by their derivations, these methods require highly intact skeletons, and therefore are limited to less than half of the complete POD sample. In some instances, the dimensions of missing elements can be estimated from elements with known measurements, and thus expand the available sample. This is discussed in detail in the next chapter.

Individual stature can be estimated from skeletal elements using two methods: “anatomical” methods that involve the summation of component skeletal elements contributing to stature, or “mathematical” methods that rely on regression formulae generated between an element’s dimension and the known statures of individuals in a sample. An anatomical method is favored in this dissertation because it does not rely on a reference sample in their determination and take group and individual variation in proportions into account when statures are calculated. This study uses a recent revision of Fully’s (1956) method (Raxter et al., 2006), which involves the summation of cranial height (BBH), maximum vertebral heights of C2 to L5 (or L6), the height of the first sacral element, femoral bicondylar length (FBL), tibial “physiological” length (TFL), and talocalcaneal height (TCH). This summation yields a skeletal “stature,” which is in turn converted into “living” stature using an equation that accounts for missing tissue (Raxter et al., 2006). An age-specific formula is necessary for accurate stature estimation (Raxter et al., 2007), so average ages for age ranges are used (e.g., 30-39 is computed as 35). Raxter et al. (2007) demonstrated that this yields reliable results. In the POD, 927 skeletons retain the necessary components to allow for stature estimation using this revised Fully method; the region and sex distribution are summarized in Table 4.8.

Table 4.8. Subset of POD sample eligible for Fully technique anatomical stature reconstruction

Region	Total	Males	Females
Western Arctic	168	89	79
Central Arctic	48	30	18
Great Plains	75	41	34
Prairie & Eastern Woodlands	136	76	60
Southeastern U.S.	207	112	95
Great Basin	11	9	2
U.S. Southwest	170	91	79
Pacific Northwest	50	33	17
Western Plateau	8	5	3
California	104	55	49
South Texas	19	12	7
Guatemala	1	0	1
Ecuador	5	1	4
Peru	28	16	12

Obviously, in order for stature to be compared among groups wherein few or no individuals can have statures estimated anatomically, another method for stature estimation will need to be employed. In many previous bioarchaeological studies, researchers have used mathematical stature estimation equations generated for reference populations genetically distinct from the American human groups being investigated. For example, equations developed by Trotter and Gleser (1952) for United States European-descent whites have been used to estimate statures of Inuit (e.g., Auerbach and Ruff, 2004). Although this usage is somewhat justified by similarity of crural indices (and, by implication, general linear proportions) between these two groups (Auerbach and Ruff, 2004), the stature estimations are prone to high amounts of error when the reference sample and estimated sample are from such genetically and environmentally distinct populations (Holliday and Ruff, 1997; Konigsberg et al., 1998).

Some more regionally appropriate regression equations for estimating stature have been generated, such as Genoves (1967) and Sciulli et al. (1990), though these also have limitations. Genoves' equations (1967) were created from a sample of 235 cadavers of lower socioeconomic level individuals living in Mexico during the mid-twentieth century. In his paper, Genoves dismissed problems of sample representation of population diversity within Mesoamerica, and stated that, because of the lower economic class represented in his cadaveric sample, it was ideal for generating equations for pre-contact human populations. However, the appropriate sample to which his estimation equations should be applied is limited to Mesoamerica and the United States Southwest, and differences in subsistence and population stress within this region might introduce high amounts of error. Sciulli and Giesen (1993) (a revision of Sciulli et al., 1990) employed a sample of 171 archaeological skeletons from the central Ohio River Valley and nearby region, including humans from three general temporal periods. These were used in an anatomical stature reconstruction method (based on Fully, 1956) to create individual statures, from which regression formulae were calculated. However, slight underestimates in Sciulli's vertebral height measurements (as he used anterior midline rather than maximum heights), as well as inaccurate positioning of the talus and calcaneus (see Raxter et al., 2006), likely resulted in underestimated statures.

Sciulli and colleagues, though, developed a useful method for determining statures in archaeological samples. Given that much of the POD sample's geographic and temporal diversity is represented in the 927 individuals eligible for anatomical stature estimation (Table 4.8), it is reasonable to apply Sciulli's method in creating new equations for stature estimation from long bones for the remainder of the POD sample. These regression equations are generated using the OLS (Type I) model, and the resulting equations are

discussed in Chapter 6 (Results). In POD regions and time periods for which no substantial numbers of skeletons are available from which to generate a mathematical stature estimation formula, regression equations generated from geographically proximate samples with statistically similar body proportions (crural index and relative torso height) are used.

The same dimensions used in estimating stature with the anatomical method may also be used in an alternative method for examining relative torso height. This other method involves including BBH, XC2-XC7, and XS1 in the calculation of upper body length, and TCH in the calculation of lower limb length. Unlike the method described in the previous subsection (see Equation 4.4), this alternative gives a closer approximation of upper body to lower body proportions. It is a closer estimation of “relative sitting height” in the anthropometric literature. Unfortunately, as indicated in Table 4.8, only one third of the total POD sample is eligible for this derived morphology. Thus, this method was used to compare skeletal results in this study with anthropometric study results culled from the literature. The method described in Equation 4.4 will be used for the majority of analyses comparing groups within the POD and in comparisons with the COD (with the requisite vertebral and tibial measurements corrected with regression formulae generated using the POD).

The morphometric method for body mass estimation also makes use of statures estimated using the anatomical revised Fully method (Raxter et al., 2006), as well as those computed using the mathematical method regression formulae derived from the anatomical method estimations. Following Ruff (1994), Ruff et al. (1997) and Ruff et al. (2005), mass can be determined by modeling humans as a cylinder with a length equal to “living” stature, and diameter equal to “living” bi-iliac breadth:

$$\text{♂: } (0.422 \times \text{Living stature}) + (3.126 \times \text{“Living” bi-iliac breadth}) - 92.9$$

$$\text{♀: } (0.504 \times \text{Living stature}) + (1.804 \times \text{“Living” bi-iliac breadth}) - 72.6$$

These equations, developed by Ruff and colleagues in 2005, incorporate high latitude populations and therefore are more appropriate for this dissertation, given the geographic distribution of the POD sample. Auerbach and Ruff (2004) suggested that the morphometric method should be used, rather than the mechanical method, if possible. These equations can only be used with 844 skeletons, though, whereas the majority of the sample has intact femoral heads. Thus, body mass estimations from the femoral head will be used.

Yet, which femoral head estimation equation should be used? Equations based on three reference samples have been created for estimating mass from the femoral head. Ruff et al. (1991) based their equations on a sample of 80 individuals from Baltimore, Maryland. McHenry's (1992) equations used four sample means of modern North Americans, African Pygmies, and Khoisan as a basis. Grine and his colleagues (1995) utilized ten sex-specific means for samples of higher-mass African Americans, European Americans, and Native Americans¹⁸. McHenry's equations were developed for use on australopithecines, and therefore the mean body mass for his sample was skewed toward the lower end of the range of modern human body masses. In contrast, Grine et al.'s equations were developed for estimating the body mass of the large-sized fossil *Homo* remains found at Berg Aukas, Namibia, and so the mean body mass of their sample was skewed toward individuals with higher body masses. Ruff et al.'s equations were generated from a sample that, comparatively, had a body mass range that is intermediate for modern humans (see Auerbach

¹⁸ Note that Grine et al. used Pecos Pueblo skeletons as part of their sample. Pecos Pueblo is included in this study as part of the EOD, but skeletons from that location are not used in determining the utility of the various femoral head body mass estimation equations. Neither McHenry or Ruff and colleagues used any samples from pre-contact America.

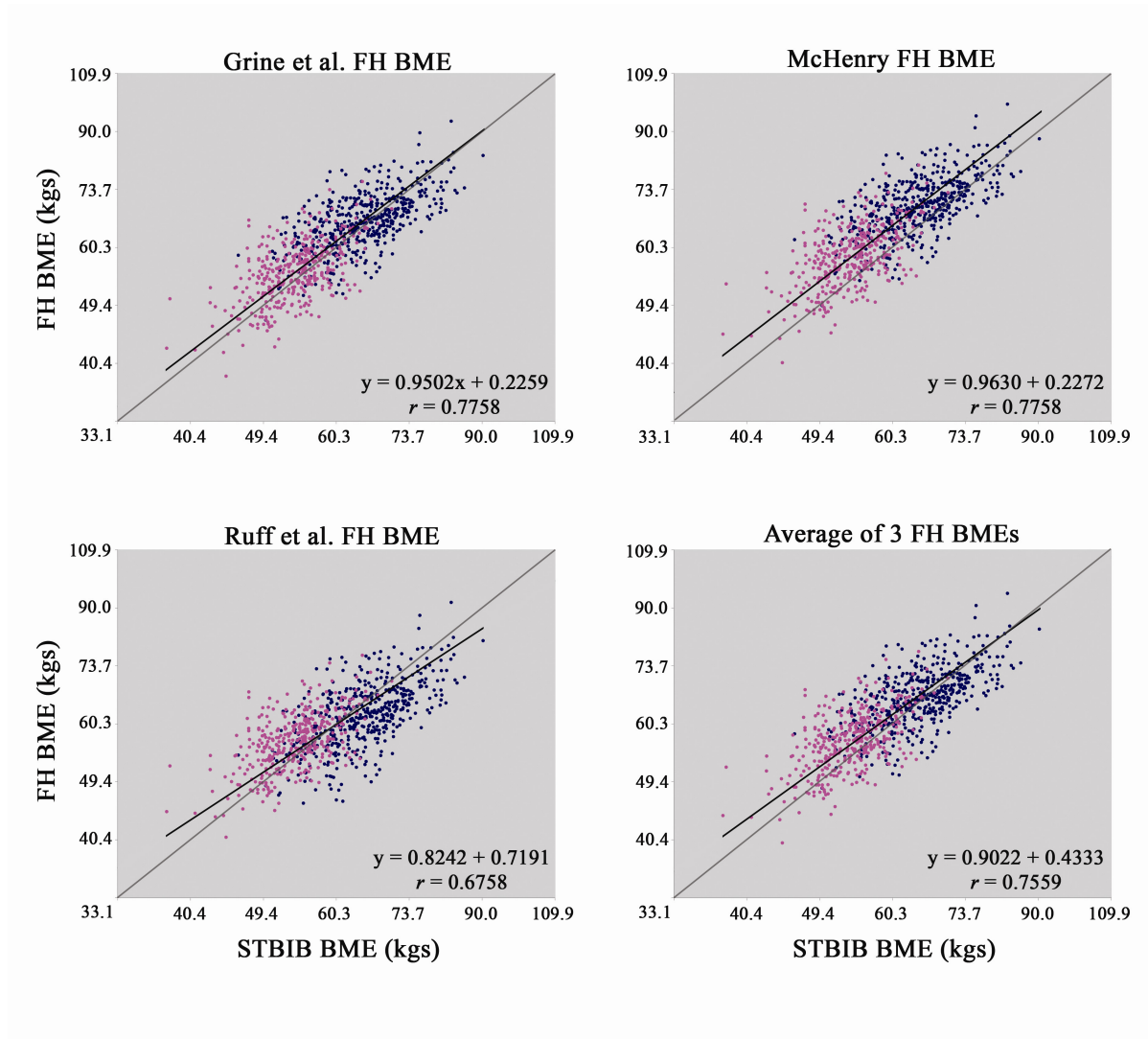
and Ruff, 2004). Auerbach and Ruff (2004) suggested that the equations developed by Ruff et al. (1991), McHenry (1992), and Grine et al. (1995) should be averaged in most circumstances in order to minimize the biasing effects of the sample composition from which each original equation was derived.

It is informative to test the accuracy of each of these equations, as well as their mean, before defaulting to the advice of Auerbach and Ruff, as American populations used in their study were not as diverse (genetically, geographically, and temporally) as those represented in the POD. After the methods employed by Auerbach and Ruff (2004), each femoral head estimation technique was compared with body masses determined using the morphometric method. (See Auerbach and Ruff, 2004, for a discussion of the methods and the justification of this comparison.) The resulting correspondence of each method is shown in Figure 4.5, along with the resulting reduced major axis regression equation and correlation coefficient. It is evident, based on these results, that the Grine et al. equation has the best performance (possibly due to the medium to high body masses of his reference sample), with the smallest size effect or systematic bias. The Grine et al. (1995) mechanical method equation for estimating body mass will be used in this dissertation, and is recommended for all derivations of body mass in human samples from the New World.

4.3.4: Special morphological considerations: robusticity and asymmetry

In addition to the derived morphologies described above, two additional sets of morphological variables are derived from the skeletal measurements: robusticity and asymmetry. These are calculated only on the limb bones, with special attention focused on the diaphyseal breadths. As explained in Chapter 3, these two sets of morphologies are used to approximate the effects of activity—namely, actions associated with mobility and

Figure 4.5. Performance of femoral head body mass estimates (FH BME) against stature/bi-iliac breadth body mass estimates (STBIB BME). $n = 835$. Blue, males; pink, females; black line, RMA regression; grey line, line of equivalence. Note that the equations provided, which are for log-transformed BMEs, are correct for these regressions; the body masses in the scales have been converted from the natural log scale for easier interpretation.



subsistence—on the skeleton.

Robusticity, as used in this dissertation, describes the relative strength of diaphyseal breadths, scaled by bone length and body mass (Ruff, 2000b). “Strength” in this case is the section modulus (Z) of a diaphyseal breadth, which is the maximum stress at the greatest distance from the neutral axis of the diaphysis in loading (Martin et al., 1998). Knowing the cross-sectional properties of bone, which in turn requires knowledge of the structure and distribution of cortical and trabecular bone, is necessary to obtain an accurate estimation of Z (O’Neill and Ruff, 2004). However, external breadths of diaphyses may be used as a proxy to Z . These should scale approximately to the third power relative to Z (that is, the diameter³ $\propto Z$) (see Ruff et al., 1993, for discussion). Assuming that maximum stress is constant in all bones (which is justifiable by the similar material properties of all long bone diaphyses in humans and other vertebrates), strength should be proportional to overall size, which Ruff (2000b) shows is best represented by body mass and bone length. Thus, in order to examine relative robusticity of diaphyses, robusticity is calculated as:

$$\frac{D^3}{BM \times L} \times 1000$$

“ D ” is the diameter (external breadth) of the diaphysis (in millimeters, averaged between left and right sides), “ BM ” is body mass (estimated from the femoral head), and “ L ” is the maximum length of the element under consideration (also in millimeters). These are calculated for the average diaphyseal breadth (mean of anteroposterior and mediolateral breadths), and individually for AP and ML breadths.

The robusticities of the diaphyseal midshafts of humeri and femora are compared in analyses. Previous studies (e.g., Wescott, 2001; Weiss, 2003; Ruff, 2006) have demonstrated

that strengths of these skeletal elements distinguish different limb loading patterns well. Stock (2002, 2006) did indicate that the distal elements of limbs may better reflect unique usage of the upper limb within groups that practice similar activities. However, as the analysis of robusticity in this dissertation is only concerned with relative limb strength in relation to general modes of subsistence, comparisons are limited to the diaphyseal breadth dimensions of these two bones.

Robusticity is compared using three methods. First, the robusticity values for the upper limb and the lower limb are compared among groups practicing different subsistence modes. Second, the relative strength of the humerus to the femur for each group is compared to distinguish subsistence groups possibly engaging in activities that utilize the upper limb more relative to the lower limb. Finally, sexual dimorphism in robusticity is compared among subsistence groups, in which the mean female robusticity for an element is subtracted from the mean male value and then divided by the average of the two sexes' robusticities (thus, positive values are higher robusticities for males).

In addition to robusticity, directional bilateral asymmetry and absolute bilateral asymmetry of limbs are examined to assess differences among groups employing various modes of subsistence. Directional bilateral asymmetry is the difference in the size between the left and right sides of a given bilateral dimension, such as the difference in the length of the left and right humeri, while maintaining the direction of the asymmetry (positive, right; negative, left). Absolute bilateral asymmetry is the absolute value of this. As described in Auerbach and Ruff (2006), these are best determined as percentages of asymmetry, calculated as:

$$\%DA = \frac{(\textit{Right side measurement} - \textit{Left side measurement})}{(\textit{Right side measurement} + \textit{Left side measurement}) \div 2} \times 100$$

$$\%AA = \frac{(Maximum\ measurement - Minimum\ measurement)}{(Maximum\ measurement + Minimum\ measurement) \div 2} \times 100$$

Wherein “%DA” is the percentage directional asymmetry for a given dimension and “%AA” is the percentage absolute asymmetry for that dimension; the former demonstrates the directionality of asymmetry in a given dimension, while the latter indicates the amount of asymmetry present in any given dimension relative to other dimensions. The difference between measurements of the right and left sides or maximum and minimum are divided by their respective averages in order to scale all of these dimensions equally, allowing for the direct comparison of asymmetries among dimensions of different sizes. %DAs that are positive indicate a right-side biased asymmetry; negative values indicate a left-side biased asymmetry.

Unlike the calculation of robusticity, asymmetry percentages are calculated for most limb bone measurements, including the clavicles but excluding the fibulae. Like robusticity, they are calculated by sex. These are determined for three sets of dimensions: lengths, articular breadths, and average diaphyseal breadths. The majority of analyses, however, focus on diaphyseal breadths, as these should be the most representative of activity, and vary the most between subsistence groups (Auerbach and Ruff, 2006).

Also, in addition to percentage asymmetries, OLS regression residuals of left side measurements against right side measurements of a given dimension are used. These residuals may be correlated between pairs of functionally-related dimensions among individuals in order to determine if asymmetries significantly covary within limbs. For example, the residuals of humeral lengths are correlated with the residuals of radial lengths (see Auerbach and Ruff, 2006, for discussion).

4.4: Subsistence categories

General categories have been devised to summarize the diversity of subsistence strategies employed by the various cultures represented in the POD and EOD samples. This section enumerates these categories and their components. These are based on archaeological and ethnographic evidence. Site records and analyses, when available, have been used to best designate the strategies employed at specific sites. The six categories used for analyses are listed in Table 4.9, alongside descriptive data on the number of sites and skeletons represented in each category. The category assigned to each site is listed in Appendix I.

Many of the categories are similar to those designated by Dr. Daniel Wescott in his dissertation (2001). As he correctly noted, the divisions of subsistence strategies are somewhat arbitrary and instituted for the convenience of analyses. Effectively, each category contains a great variety of subsistence methods, influenced by differences in terrain, flora and fauna, raw materials for tool production, and intergroup interactions. For example, the occupants of the Aleutian Islands and of the Channel Islands are both considered marine hunter-gatherers, though their diets were composed of drastically different marine prey. Arctic peoples consumed large amounts of blubber and the meat of sea mammals, in addition to some terrestrial mammals (e.g., large ungulates), whereas groups living in the Channel Islands primarily exploited marine invertebrates, as well as seals, shark, and some larger deepwater fish species (Fagan, 2005). However, overemphasizing these differences among groups or further dividing them would generate too many subsistence categories for useful comparisons. Thus, just as with the geographic regions used in this dissertation, the subsistence categories are an archaeologically-informed heuristic device.

4.4.1: Categories

Broad-spectrum hunter-gatherer (BSHG). This subsistence category represents the inland subsistence strategy of the proto-Archaic early Holocene, as well as many of the groups living in Early Archaic period cultures. In general, these populations lived in small, highly mobile groups that exploited a variety of resources seasonally and geographically. Groups practicing this form of subsistence in the POD and EOD are limited to those living in the Great Basin and those dwelling in the Texas coastal region. Researchers have hypothesized that such populations persisted by occasional social interactions for the trading of technologies, food, and genes (Bamforth, 1988; Frison, 1991; Anderson, 1996).

Freshwater hunter-gatherer (FHG).¹⁹ Unlike the broad-spectrum hunter-gatherers, these groups were more sedentary (in many cases, occupying a site seasonally) and exploited a more narrow range of local food resources (Bickel, 1978). As the name of the category implies, these groups were found adjacent to rivers and lakes (which may have, in turn, been seasonal). In addition to fish and invertebrate species, these groups consumed small- and medium-sized terrestrial game (e.g., rabbit and deer), and a variety of plant species. In some cases, such as in the western Sacramento River Valley, groups may have exploited both riverine and ocean bay resources, though the habitation sites in which burials were uncovered for these groups were inland by rivers (Fagan, 2005).

Marine hunter-gatherer (MHG). Like the freshwater hunter-gatherers, groups in this category were more circumscribed in which food resources they exploited. By definition, these groups differed from their freshwater counterparts in the location of their archaeological sites, but also in the general composition of their diets. Many lived on ocean

¹⁹ This category is similar to the more regionally specific “Woodland hunter-gatherer (WDHG)” category used by Wescott (2001).

Table 4.9. POD sample composition by subsistence categories

Subsistence category	Region	Number of sites	Number of skeletons
Broad-spectrum hunter-gatherer (BSHG)	Western Arctic	0	0
	Central Arctic	0	0
	Great Plains	4	22
	Prairie & Woodlands	0	0
	Southeastern U.S.	0	0
	Great Basin	9	17
	U.S. Southwest	0	0
	Pacific Northwest	0	0
	Western Plateau	1	1
	California	0	0
	South Texas	2	18
	Guatemala	0	0
	Ecuador	0	0
	Peru	0	0
	ALL		16
Freshwater hunter-gatherer (FHG)	Western Arctic	2	89
	Central Arctic	0	0
	Great Plains	0	0
	Prairie & Woodlands	3	28
	Southeastern U.S.	10	248
	Great Basin	0	0
	U.S. Southwest	0	0
	Pacific Northwest	0	0
	Western Plateau	2	15
	California	5	143
	South Texas	0	0
	Guatemala	0	0
	Ecuador	0	0
	Peru	0	0
	ALL		22
Marine hunter-gatherer (MHG)	Western Arctic	7	200
	Central Arctic	4	90
	Great Plains	0	0
	Prairie & Woodlands	0	0
	Southeastern U.S.	2	62
	Great Basin	0	0
	U.S. Southwest	0	0
	Pacific Northwest	10	118
	Western Plateau	0	0
	California	6	103
	South Texas	2	35
	Guatemala	0	0
	Ecuador	0	0
	Peru	0	0
	ALL		31

Incipient horticulturalist (IH)	Western Arctic	0	0
	Central Arctic	0	0
	Great Plains	0	0
	Prairie & Woodlands	10	157
	Southeastern U.S.	5	10
	Great Basin	7	36
	U.S. Southwest	0	0
	Pacific Northwest	0	0
	Western Plateau	0	0
	California	8	133
	South Texas	0	0
	Guatemala	0	0
	Ecuador	0	0
	Peru	0	0
	ALL	30	336
Village horticulturalist/ hunters (VHH)	Western Arctic	0	0
	Central Arctic	0	0
	Great Plains	8	151
	Prairie & Woodlands	0	0
	Southeastern U.S.	0	0
	Great Basin	0	0
	U.S. Southwest	0	0
	Pacific Northwest	0	0
	Western Plateau	0	0
	California	0	0
	South Texas	0	0
	Guatemala	0	0
	Ecuador	0	0
	Peru	0	0
	ALL	8	151
Agriculturalist (AGR)	Western Arctic	0	0
	Central Arctic	0	0
	Great Plains	0	0
	Prairie & Woodlands	6	177
	Southeastern U.S.	15	290
	Great Basin	0	0
	U.S. Southwest	21	476
	Pacific Northwest	0	0
	Western Plateau	0	0
	California	0	0
	South Texas	0	0
	Guatemala	1	15
	Ecuador	1	13
	Peru	5	100
	ALL	49	1071

coastlines or on islands, and acquired much of their sustenance from marine mammals, large sea fish, and some coastal species (such as migratory birds). On the Columbian Plateau and the Alaskan mainland, some groups foraged and hunted inland from the coast along natural drainage basins and rivers (Fagan, 2005).

Incipient horticultural (IH). This is a broad category assigned to sedentary groups that, while not engaging in large-scale agriculture, did tend and grow consumable plant species on a small scale. Groups in this category continued to actively hunt faunal prey, and maintained varied diets (though not as diverse as the hunter-gatherer groups), though they had a greater reliance on their cultigens (Johnson and Johnson, 1998; Wescott, 2001). Some of the later inland Californian sites are included in this category on the basis of more intensive acorn and buckeye maintenance and harvesting (Fagan, 2005).

Village horticulturalist/hunters (VHH). In the Great Plains, a unique culture developed during the Late Woodland that combined some intensive agriculture of maize and beans with varying degrees of dependence on wild plant gathering and large mammalian prey (namely bison) hunting (Wedel, 1983). Many of these groups were residentially sedentary, especially those living in the eastern Plains along the Missouri, Red, and Arkansas Rivers.

Agriculturalist (AGR). Agriculturalist cultures varied widely in their cultivars throughout the Americas. Gourds, legumes, tubers, maize, and some cereals were grown in various combinations throughout the New World. (Maize was predominantly harvested among the agriculturalists in the POD sample.) However, all agriculturalists were sedentary, with low mobility and a limited variety of cultivars farmed with high intensity compared to the other subsistence groups listed above. In general, these societies were also more socially stratified than cultures practicing other subsistence strategies.

4.4.2: Application

These groupings of subsistence strategies are used in analyses of morphological variation within geographic regions over time, and in examining variation within and among geographic regions in the same temporal period. As outlined in the hypotheses of Chapter 3, the effects of subsistence modes on morphological variation are explored in contrast to the effects of climatic factors. No assumption of a “hierarchy” among subsistence categories is made in analyses. All are assigned nominative dummy variables for analyses without supposition of “advancement” among categories. More specific discussion of the use of these categories in analyses may be found below in the “Statistics” section of this chapter.

These subsistence categories are summarized as well in Figure 4.1, demonstrating the site temporal ranges by state/province/country. Blue lines represent all hunter-gatherer groups (BSHG, FHG, MHG), purple indicates “transitional” subsistence groups (IH and VHH), and red are agriculturalist groups (AG). Immediately, it is evident that the geographic and temporal distributions of subsistence categories are not random; some locations are represented by only one subsistence category (e.g., Arizona), whereas others consist of groups with multiple categories (e.g., Tennessee). This is an issue under further consideration in the “Statistics” below (Section 4.6).

4.5: Climatological data

In previous studies, the relationship of climatic variables and morphological variation has been examined using modern climatic data collected instrumentally from weather stations since the 1930s (e.g., Kondrat, 1995). These data include temperature extremes and means, in addition to precipitation means. While this is potentially useful for examining humans who lived within the last 500 years (after the so-called “Little Ice Age”), use of contemporary

climatic data does not adequately represent climatic conditions preceding this period (e.g., the effects of the “Little Ice Age,” “Medieval Warm Period,” drought in the United States Southwest, the mid-Holocene hypithermal event, the drying of Lake Lohontan, etc.) (Herrmann, 2002). Given the temporal and geographic ranges of samples studied in this dissertation, an effort must be made to represent adequately climatic conditions for these groups to examine accurately the relationship of climate and morphology. Thus, the incorporation of paleoclimatic data is essential to these analyses.

Recent decades have been marked by a substantial increase in available paleoclimate data, based on dendrology, palynology, paleoatmospheric studies using ice core firm, and paleontology using indicator species. These data have provided the basis for the modeling of general climatic trends (see, e.g., Moberg et al., 2005), as well as region-specific centennial and decadal patterns (e.g., Shennan, 2005). One of the most complete paleoclimatic models for the Holocene in North America may be reconstructed using pollen samples (Overpeck et al., 1992; Williams et al., 2006). Additional data for the last millennium are available in the United States Southwest from tree-ring observations, many of which are preserved in human-built structures (e.g., pueblos) (see the Climax web site: <http://www.ispe.arizona.edu/climax/>).

In these analyses, past climates were modeled using modern analogues of past pollen distributions. This method is widely used by climatologists and is one of the best available methods for reconstructing paleoenvironments (Birks and Birks, 2005). Plant species—especially tree species—exist in modern clines determined abiotically by seasonality, temperature ranges, precipitation, and soil composition (Perry, 1994). Native species currently extant in the Americas existed throughout the Holocene. Thus, using current climatic conditions for species, obtained from the aforementioned instrumental data gathered

over the last half-century, past distributions of pollen species indicate similar climatic conditions (under the principles of uniformitarianism). Although this is an imperfect method for modeling the conditions of past climates, it is more useful than applying general climatic trends which, while descriptive of overall climate changes, fail to account for regional variation. In the United States Southwest, tree-ring data will also be used, as all of the sites from that region observed in the POD date to within the last millennium (see Figure 4.1 and Table 4.3).

4.5.1: Data

The National Oceanographic and Atmospheric Administration (NOAA) maintains two resource sites for climatic data. Modern instrumental data gathered by direct measurements at weather stations have been accumulated over the last fifty or more years from hundreds of locations, and have been made available in World Wide Web online databases (located at <http://lwf.ncdc.noaa.gov/oa/climate/climatedata.html>). Paleoclimatic data, including pollen data, are also made publicly available through the National Climatic Data Center's Paleoclimatology Program (<http://www.ncdc.noaa.gov/paleo/paleo.html>), wherein both databases and mapping software are available, aggregated from palynology research conducted by multiple researchers throughout North America. These databases are used as the sources of most of the climatological data utilized in this study. In general, the modern temperature and precipitation ranges for a group of plant species in a given region are applied to wherever those species coincide in past sites, based on the data made available by NOAA. Summaries of data for each site (pollen types used and sources, temperature data, and precipitation data) are provided in Appendix IV.

As noted previously, the United States Southwest is exceptional in terms of paleoclimate data. Although pollen data exist for Arizona and New Mexico (e.g., Wright et al., 1973; Davis and Shafer, 1992), dendrologic studies provide a more precise method for paleoclimate models. Like the pollen data used for the rest of North America (and in conjunction with available pollen data), tree-ring data are used to select the most appropriate modern site climatological data to represent the past climate. Sources for these data may also be found in Appendix IV.

Finally, although paleoclimatic models for South America are under continuous development, they are not as extensive as those available for North America. As such, the pollen records (as well as tree-ring and ice core) for sites in Ecuador and Peru cannot be used effectively in estimating past climatic conditions there. In the case of these sites, more general regional paleoclimate trends are used to apply a general correction to temperature and precipitation data (Hansen et al., 1984; Thompson et al., 1985; Seltzer et al., 2000; Eitel et al., 2005).

4.5.2: Application

Mean annual temperature, warmest month mean high temperature, coldest month mean low temperatures, and mean monthly and annual precipitation, have been determined from instrumental data recorded until 1990.²⁰ These means are used directly in analyses as continuous data. The temperature and precipitation data have then been applied to sites based on cross-referencing current pollen distributions with palynology data for past pollen distributions (and, where appropriate, tree-ring data in United States Southwest) or general

²⁰ The use of the year 1990 as a data cutoff is somewhat arbitrary. However, as the warmest years ever recorded occur after 1990, it is justifiable to exclude these years in determining the mean for climatological conditions. Furthermore, use of some weather stations was discontinued after the beginning of the 1990s.

paleoclimatic trend (South America) data. For example, a region currently supporting hickory (*Carya*), oak (*Quercus*) and elm (*Ulmus*) has a constrained temperature and precipitation range; regions with the same coincidence of species, by analogy, would have similar climatic ranges.²¹ Genera with narrower tolerance ranges for temperature and precipitation are favored in the application of this method. Although this creates a coarse representation of past climate, it presents a more accurate model than is possible by using uncorrected current climatic information or general global climatic trends. In addition, some plants are good indicator species for climate models, such as goosefoot (Chenopodiaceae) for arid, warm conditions. The following section, “Statistics,” provides more specific information on analyses in which climatic variables are considered in relation to subsistence categories, osteometric data, and derived morphologies.

Both the modern climate data and the “corrected” climate data (data from weather stations other than the one proximal to the site, or from specific time periods of the weather station proximal to the site) are provided in Appendix IV. Sixty-one sites did not require any changes made to available temperature or precipitation data. The corrections made to climatic variables for the majority of the remaining sites are minor, mostly constituting mean adjustments of less than two degrees Celsius. Notable differences occur at some sites and time periods, however, such as in mean temperatures and precipitation in the Southeastern U.S. during the mid-Holocene hypisthermal (Figure 4.6a), or shifts in the amount of rainfall during the droughts in the U.S. Southwest at the end of the Little Ice Age (Figure 4.6b).

²¹ An acknowledged problem with the application of pollen data is the tendency for pollen present at a sampled location to potentially over represent genera that produce more pollen, are more widely distributed (and therefore have a higher chance of being represented in a random sampling of that location), or are more morphologically distinctive than other pollens. Some studies have attempted to take this bias into consideration and show “corrections” for underrepresented genera (e.g., Davis, 1999). As the focus in the use of pollen data in this dissertation is on the presence of indicator genera and their overlap, rather than relative abundance, this problem has only a limited effect on the accuracy of climate models.

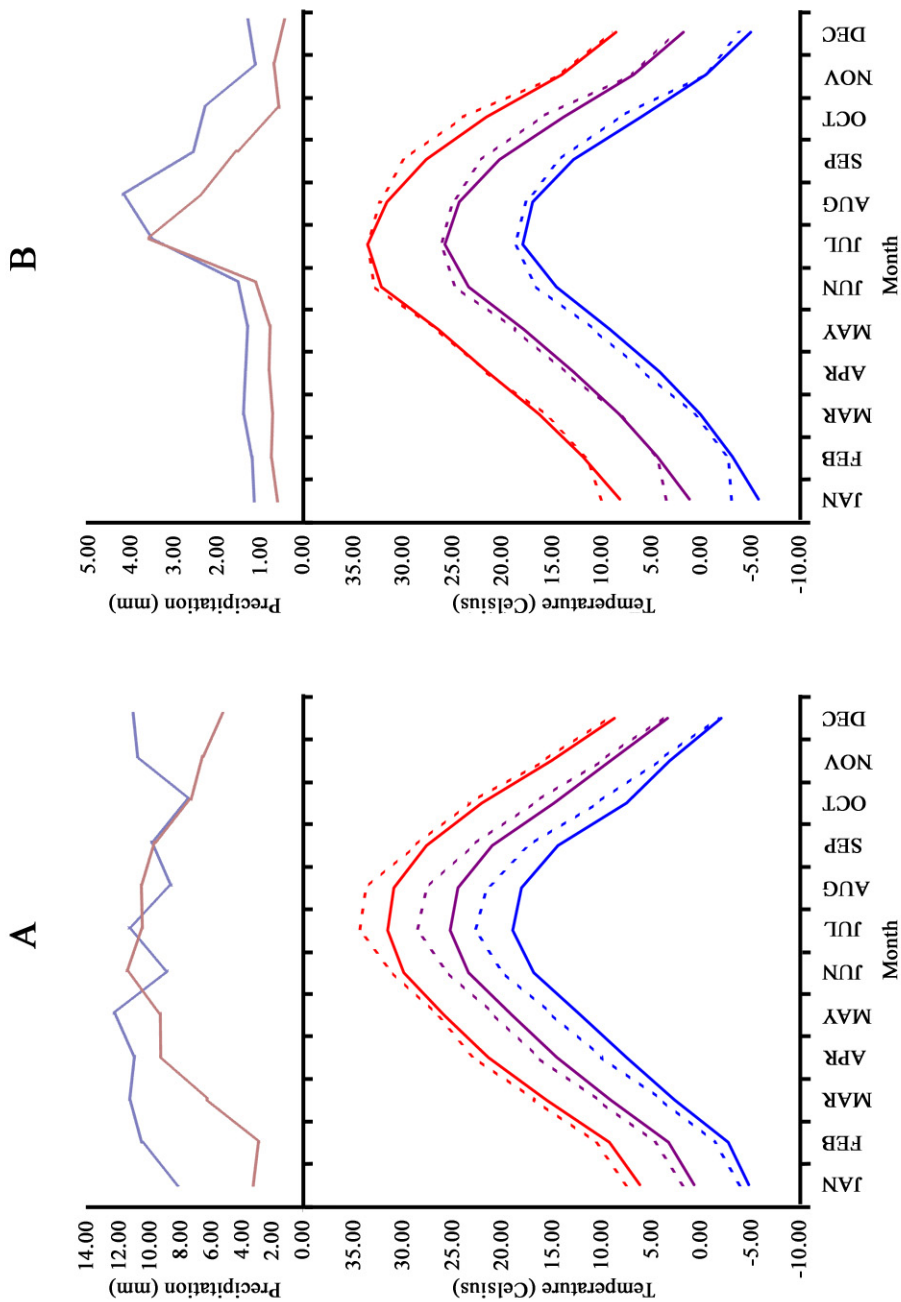


Figure 4.6. Comparisons of modern climate and “corrected” climate for sites in the POD: **A)** Indian Knoll (#58); **B)** Paa-Ko (#82). Solid temperature lines, modern mean temperature values; dashed temperature lines, “corrected” mean temperature values. Temperature lines: red, warmest month mean high temperature; purple, mean monthly temperature; blue, coolest month mean low temperature. Precipitation lines: dark blue, modern precipitation; brown, “corrected” precipitation.

Some special considerations should be noted as a final caveat to the use of climate data as described above and in the next section. First, temperature and precipitation data are used as relative indicators of climate for a given location. It is naïve to suggest that climatic conditions remained highly consistent over the long durations over which many sites were occupied and/or used as burial grounds, or that people only experienced climates at the location at which they were buried. Indeed, nomadic BSGH, FHG, and MHG groups most likely encountered a spectrum of microclimates. Instead, just as subtle variations existed among subsistence modes but are generalized in this dissertation's analyses, climatic data are regarded to generally represent the climate of the sites to which they are assigned. Second, it would be unrealistic to suppose that modern climate data will represent past climate precisely. As noted in Chapter 2, some locations experienced relatively chaotic changes in temperature and precipitation, such as the U.S. Southwest and Great Basin over the last two millennia (Ni et al., 2002; Schimmelmann et al., 2003; Mensing et al., 2004), or the northern British Columbian coast approximately 3000-2000 yBP (Fladmark, 2001). These rapid fluctuations have been attributed to be, in part, responsible for severe changes in cultures and subsistence (i.e., Jones et al., 1999; deMenocal, 2001). Capturing the precise changes in temperature and precipitation during these events is not possible with the resolution available from the available data. Likewise, modern scientifically-recorded climatic data include short-term fluctuations in climate, such as mild droughts, but the length of data observations at most locations (on average at least 60 years) will minimize the effects of these variations. In some cases, models suggest that recorded meteorological aberrations closely resemble projected past events, such as the 1950-1956 C.E. drought in the Southwest and the extended drought there occurring approximately 500 yBP (Ni et al., 2002). However, this is the

exception; rarely are modern recorded data hypothesized to closely mimic past climatic circumstances. Thus, in most cases, the most appropriate data that model the climatic conditions implied in paleoenvironmental studies are used, with the acknowledgement that there are inherent limitations to the use of these data.

4.6: Statistics

The combined data sets detailed in this chapter are used to test the three sets of hypotheses proposed at the end of Chapter 3. This section describes general statistical considerations in analyzing the osteological, climatic and subsistence data, and provides examples of how the methods are employed. Much of the description of the specific use of statistics, however, is reserved for the reporting of analytical results in Chapter 6. As some statistics are dependent on the results of other statistics, the order in which statistics are presented below does not necessarily reflect the order in which they will be used. Because of the nature of the data used—proportional, nominal, and scalar—different assumptions of the data and statistical methods are used.

In general, tests are conducted on the appropriate subsection of the total sample with all necessary measurements, and on the overall sample (where sample sizes will vary with each factor considered). Few measurements are estimated (see Chapter 5), and these are regarded to be highly accurate. Individuals with estimated measurements will be treated the same in analyses as those with those measurements originally present. The results of tests using only those individuals with all necessary measurements will be compared with the results generated from tests using the complete sample, so that the biasing effects of dissimilar samples (i.e., small subsets of the POD, EOD, or COD) can be detected.

All analyses are conducted using Microsoft Windows-compatible software. Most statistical analyses were conducted in SPSS for Windows, version 12.0. Specialized statistics—reduced major axis regressions, Mantel tests and other variance/covariance (V/CV) analyses—were conducted using the freeware PopTools add-in for Microsoft Excel (<http://www.cse.csiro.au/poptools>).

4.6.1: General approaches and assumptions

Many of the sites examined, not including those from the early Holocene, consist of very few individuals (<10) (see Table 4.1 and Appendix I). In cases where multiple sites are geographically and temporally proximate, aggregation of samples is employed and constitutes a “sample” (most of these are indicated in Appendix I). However, cultural differences exclude this option for a number of sites (e.g., the four cultures represented at Point Hope, wherein two have very small samples). Thus, sites not designated as combined with others in analyses are not considered when samples (individual, large sites and aggregated sites) are compared within regions or between samples. In statistical analyses in which regions and time periods are compared, these exceptional, small samples are included, however.

As discussed in the description of the POD sample, there are significantly unequal sample sizes among groups and among regions. Statistically, this contributes to a fundamental violation of parametric test assumptions, namely the need for equal variances. This problem is immediately apparent from the descriptive statistics presented in Appendix V. Ideally, weighting the data according to expected frequencies would address this problem. This solution, however, would give a disproportionate representation to small samples, or artificially augment regional population variation. Additionally, given the number of

permutations among sites, regions, and temporal periods examined in the following analyses²², no single weighting factor will be adequate for all tests; weights would need to be devised for each analysis. Therefore, no weighting of data prior to analyses is attempted.

The simplest way of circumventing this problem is the use of sample means for comparisons. This addresses the problem of unequal sample sizes, though smaller samples are less likely to accurately represent the central tendency for a site or group of aggregated sites. Again, for this reason, sites that cannot be aggregated and that have very small samples will not be used in comparisons using sample means. In addition, the use of means effectively nullifies the contribution of individual variation within samples to the differences observed among samples. Therefore, the employment of sample means will be especially beneficial in examining the effects of climate and subsistence, as these are not expected to vary significantly within a sample.

Not all statistics, however, can be conducted by comparing group means. The examination of individual range of variation—within sites and within regions—is a crucial component in the analyses of this dissertation. Some statistical methods may be applied to allow for the examination of this variation, even with unequal sample sizes. In the case of analyses of variance (ANOVAs)—wherein heterogenic variances have the greatest effect—Levene’s test is a good indicator of violations of homogeneity in variances and is used in all tests. When heterogenic variances occur, the use of a post-hoc test that assumes unequal variances is a viable alternative solution, although this is statistically less robust than weighting data prior to analyses. The Games-Howell post-hoc test, which is designed to work best with unequal variances and unequal sample sizes, is used in these instances.

²² This is cause for concern as well. Large sample sizes notoriously generate a Type I error; differences among groups are statistically but not necessarily biologically significant. This is taken into consideration when interpreting results, as described in the beginning of the Results chapter.

Regressions that employ variables with unequal variances generate accurate OLS equations, though the standard errors of these are not accurate (Palta, 2003). Regressions are more sensitive to the effects of multicollinearity, nonadditivity, heteroscedasticity, and autocorrelation, all of which are assessed through regression diagnostics performed during each analysis. Of these, multicollinearity and heteroscedasticity are the most likely problems encountered in this dissertation. (The large sample sizes and nature of the osteometric, climatic, and subsistence data should reduce the chances of the other errors.)

Multicollinearity may be addressed by employing components generated in a factor analysis (see below), and heteroscedasticity is reduced through the use of log-transformed data. The employment of log transformations is discussed further in the following subsections.

Sex is an established factor in many previous studies concerning human variation (see Chapters 1 and 3). Therefore, all analyses initially include sex as a factor. In instances in which a significant difference exists between the sexes, they are examined separately. In all of the data provided in Appendix V, the descriptive statistics are given for overall samples, for males, and for females.

The examination of the three osteometric data sets is conducted in a stepwise manner. All analyses are initially tested with data in the POD; interobserver error is not a factor in these analyses. This data set also allows for the testing of hypotheses that concern stature, robusticity, upper limb bilateral asymmetry (as an indicator of activity), and cranial proportions, factors for which data were not collected in the EOD (with the exception of robusticity and asymmetry data in the Goldman Data Set) or COD. The EOD data are used for hypothesis-testing that examines limb proportions and body mass. Their inclusion, though, occurs only after the data for the POD are examined initially. Data in the EOD are

considered to expand the regional results reported using skeletons in the POD, and so are used to examine the hypotheses directly. As the comparative European and African data have established clinal patterns of variation (e.g., Holliday, 1995; Holliday, 1997a; Ruff, 2002a), the patterns established by examining the COD are used to place the New World results into the context of established Old World patterns. No direct statistical comparisons are made between the POD, EOD and the COD.

Provisionally, I examined some skeletal groups in common with those included in both Wescott's and Holliday's data. Eighteen skeletons from the Larson Site (39WW2, #92 in Appendix I) are in common with Wescott's data, and eleven skeletons from the Poundbury Romano-British cemetery (Goldman Data Set) are in common with Holliday's data. Thus, interobserver errors may be calculated (White, 2000). The results of these are presented in Table 4.10. Note that only long bone measurements may be compared with either data set. These errors are indicative of the measurements in common between the data sets. Generally, interobserver errors are very low (less than 1% in almost all cases), reinforcing the use of these additional data sets in the analyses of this dissertation.

One final note should be reiterated concerning the early Holocene human sample before proceeding with the outline of statistical tests. The antiquity of these skeletons has allowed for limited preservation and miniscule sample sizes. The data provided by each, while invaluable, may not be indicative of the population(s) from which they came. With isolated individual samples, however, this cannot be known. Statistically, including a sample of a single individual in the analyses described in the following subsection would be unsound. Properties of each skeleton could be considered a "mean" for their unknown populations, but this is an unlikely (and naïve) proposition, and still fails to address the statistical issues

Table 4.10. Percent interobserver errors with Wescott’s and Holliday’s data sets¹

Measurement	Interobserver error with Wescott (<i>n</i> = 18)	Interobserver error with Holliday (<i>n</i> = 11)
CML	0.195%	--
HML	0.137	0.118%
HHD	0.741	--
HEB	0.289	--
RML	0.066	0.300
UML	0.089	--
FML	0.050	--
FBL	0.030	0.106
FHD	0.448	0.212
FEB	0.325	--
TML	--	0.077
TFL	0.173	--
FiML	0.364	--
BIB	--	0.338

¹ Most of the measurements taken in the POD were not taken by Wescott or by Holliday. See Table 4.5 for corresponding measurements. Although Wescott obtained 50% diaphyseal breadths for clavicles and for femora, comparative measures do not exist between the POD and his data from the Larson site.

created by their sample sizes. (Variances, for instance, cannot be known from single samples.) With the additional uncertainties concerning the genetic relationship of these individuals to more recent humans in the Americas (see Chapter 2), combining these individuals with more recent groups in analyses of subsistence may be conflating unrelated factors. Thus, analyses for the most ancient humans in the POD and EOD samples is limited to and reserved for higher-order (“3rd Order”) statistics.

4.6.2: 1st Order Statistics: Univariate statistics, descriptive statistics and means

The non-parametric Lilliefors test is used to assess the normality of all data distributions; it makes no assumptions about the data and is not sensitive to the effects of outliers (in contrast to the Jarque-Bera test). A basic assumption in the use of parametric statistics in the examination of the osteometric data and of the derived morphologies is that, in the overall

POD, EOD, and COD samples, those data are normally distributed. However, in small samples (i.e., aggregated sites or sites that cannot be combined with others), this assumption is not upheld; the use of parametric statistics in these small samples is untenable because of this violation. This also occurs with some proportional data and in the generation of certain factors (i.e., absolute asymmetry), which have mixed success in arcsine transformations (which fail to work well with values close to zero) (see Auerbach and Ruff, 2006). Two solutions are available: reliance on the robusticity of some “higher-order” parametric statistics (e.g., ANOVA and factor analyses) to avoid errors in significance testing, or the use of non-parametric analogues. As there are no practical corresponding non-parametric statistical methods to MANOVAs, factor analyses, or variance-covariance statistics (see “3rd Order Statistics” below), these statistics are used regardless of violations of normalcy. Multivariate statistics are generally considered robust and accurate even when data distributions fail to be normal, so long as the sample under consideration is not very small (Berry, 1993; Sokal and Rohlf, 1995). “Lower-order” statistics (ANOVA, correlations, and univariate regression), however, are more sensitive to the effects of non-normal distributions. Nonetheless, they can be replaced by statistically less-robust, but appropriate non-parametric analogues (for example, the use of Spearman’s ρ in place of Pearson’s r as an estimator of correlation). In practice, then, all data are examined for normal distributions, and when these are violated, non-parametric analogues for lower-order (i.e., “2nd Order”) statistics are utilized. Results from analyses using non-normally distributed data are always noted.

In addition to tests for normal distributions, general descriptive statistics for all of the osteometric measurements (POD, EOD, COD) and derived morphologies are provided in Appendix V. Part A (Osteometrics) provides the means, medians, standard deviations, and

ranges for all of the osteometrics, listed by dataset (POD, EOD and COD), in addition to indications for data that are not normally distributed. Part B of Appendix V provides the same information for the derived morphologies, calculated as described above and in Appendix III. Finally, the derived morphology data are summarized for the early Holocene specimens in Part C.

4.6.3: 2nd Order Statistics: General Linear Model, Correlation, & Non-parametric

The three groups of hypotheses listed in Chapter 3 are examined individually and then in combination. That is, patterns of variance, covariance and scaling in derived morphologies and in the relative contribution of measurements to those morphologies (explored using coefficients of variation) are examined initially, as well as general patterns of climatic and subsistence factors. Geographic and climatic factors are analyzed first in relation to osteometrics and derived morphologies, within temporal periods (total sample) and across time periods within a region (the Southeastern United States, as this is the only region with sites representing a broad enough temporal range with which to examine secular trends). Subsistence factors are then examined within temporal periods and, again, across time periods in the Southeastern United States. The relationship of subsistence with derived morphologies is then explored with climatic factors as a covariate.

Scaling relationships of component measurements to morphological indices are analyzed by regressing the components using reduced major axis slopes. These slopes are assessed for significant departures from isometry employing a modified Student's *t*-test developed by Hofman (1988). Positive scaling and negative scaling relationships indicate that there is a size effect in indices. That is, a positive scaling found among individuals with longer brachial indices would imply that the radius increases in length disproportionately to the

humerus. Such relationships are also investigated using coefficients of variation, which are compared statistically from ANOVA results.

Climatic data consist of mean annual temperature, coolest month mean low temperature, warmest month mean high temperature, and total annual precipitation, calculated from the NOAA instrumental data as described in Section 4.5 above. Ideally, a combined climatic factor generated from a factor analysis would be used in these analyses, though such a factor cannot. The reasons for this are detailed in Section 6.3.1 of the Results. Instead, because of collinearity among the climatic variables, correlations and semi-partial correlations are employed as an alternative means for analyzing the relationship of climatic variables with the derived morphologies; the reasons for using these univariate statistics over multivariate methods are explained below and in Section 6.3.1. Univariate ANOVAs, however, are used to determine which morphologies significantly vary among the samples under consideration for each analysis, within regions across time periods, or across regions within time periods. The results of these ANOVAs are employed to guide the correlations between climatic factors and morphologies that significantly differ among all of the samples under analysis. As outlined in the “1st Order Statistics,” sex is examined as a factor in osteometrics and derived morphologies prior to these analyses, and when significant, tests are conducted within sex.

The subsistence data, as described previously, consist of defined categories. ANOVAs and ANCOVAs are chosen to examine the relation of these dummy variables with derived morphological data. ANOVAs are used to test for significant differences in derived morphologies among subsistence groups, the results of which are examined post-hoc with the

Games-Howell tests. ANCOVAs are further employed to assess differences among subsistence groups while controlling for climatic variables.

In the ANOVAs, however, the effects of environmental factors in determining the location of subsistence practices must still be taken into account. As mentioned previously in the “Subsistence categories” section (Section 4.4.2), modes of subsistence were not distributed equally or randomly among the regions sampled. For example, agriculture is impractical in the arctic, and so all sites there consist of hunter-gatherers. Thus, when regionally comparing the relationship of subsistence categories with skeletal and morphological variables, this effectively results in missing values within regions. Model Type IV sums of squares (*SS*) (as defined in SPSS 12.0) are calculated without requiring all data and with unequal frequencies among categories (Sokal and Rohlf, 1995), and so are used (instead of Model Type III *SS*) in the analyses concerning subsistence categories.

In the instances in which non-normally distributed continuous data are under consideration (especially the osteometrics and derived morphologies), as explained in the previous section, non-parametric analogues of these statistics are used. Specifically, Kruskal-Wallis tests are used in place of ANOVAs, with Mann-Whitney *U*-tests serving as post-hoc tests. These non-parametric tests are required for analyzing asymmetries in mean long bone diaphyseal-breadths in relation to subsistence categories (see Chapter 3). (These results are compared with the results of comparisons of mean diaphyseal breadths, standardized by averaged maximum element lengths, with subsistence factors and with climatic factors.)

4.6.4: 3rd Order Statistics: Discriminant function, Mantel, MANOVA

Ideally, the relationship of environmental factors and morphology would be best

examined using multivariate statistics. However, their employment is generally limited in the forthcoming analyses. Practically, as the interaction of the climatic and subsistence factors with individual morphologies has not been established, developing an understanding of these basic relationships is essential before blindly including all factors equally in analyses. This is especially important in the case of factors that independently affect morphology; e.g., assuming an interaction between climate and temporal period in morphological change, while logical (morphology may be temporally delayed in its response to climatic variables), is difficult to determine without first assessing whether morphologies differ in relation to temperature, precipitation, or over time. The nature of the data also cautions the use of some multivariate methods. For example, there are no arctic samples prior to 4000 yBP, and so statistically significant interactions between time and climate or geography in morphological change could be spurious results of unequal sample distributions. Also, some ostensibly appropriate statistics were not found to be useful: factor analysis, for instance, was not effective in reducing the climatic or morphological data interpretably (see section 6.3.1 for discussion).

Yet, multivariate statistics are appropriate for some tests. ANOVAs are employed in analyses comparing sexual dimorphism in morphologies while controlling for regional distributions of samples. In other instances, conducting analyses with MANOVAs is less effective, such as in comparisons of morphology with climatic and geographic data; these data are continuous, but analyses of variance are better suited for comparisons of groups (Bray and Maxwell, 1985).

Analyses may indicate if various morphologies similarly correspond with the same environmental factor (such as cranial index and brachial index with temperature), but these

results do not show if these morphologies vary similarly. For example, cranial index may show a significant correlation with temperatures, but may not vary at the same “rate” as brachial index; that is, were these morphologies plotted against climate, the slopes of these morphologies would be significantly different. One way to assess these differences is by use of comparisons of the covariance among morphologies in a V/CV matrix. I devised a series of theoretical models for predicted relationships previously proposed to exist among morphologies (e.g., between brachial and crural indices), or implied by comparing empirical results (e.g., between nasal index and intralimb indices). The Mantel test was used to compare the fit of the observed V/CV matrices from the data with these theoretical models, following Ackermann and Cheverud, 2000. Using this method, significantly correlated actual data matrices and theoretical matrices would verify the accuracy of the theoretical model (which are devised in section 6.2.3 of the Results). This test is used to determine whether morphologies covary significantly apart from climatic, geographic or subsistence factors.

As repeatedly noted, the early Holocene skeletons consist of very small samples (with the exception of the Windover site), and they are ineligible for many of the statistical tests performed on the remainder of the skeletal data. However, discriminant analyses are useful in assessing how the individual early Holocene skeletons relate to the distribution and variation observed among more recent groups. Specifically, these tests would be used to try to “assign” early Holocene skeletons to more recent samples utilizing morphological variables known to differentiate more recent samples. Furthermore, the amount of variation in derived morphologies known to significantly differ among groups and regions, based on previous analyses, is used to assess how diverse the morphologies of early Holocene

skeletons were. As previous analyses also will have identified the relative influence of climate and subsistence factors on these morphologies, potentially, variation among early Holocene skeletons may be identified as being driven, in part, by these factors.

The next analytical step beyond this dissertation is to employ additional appropriate multivariate methods in assessing the interactions among the environmental factors and their relative influence on morphology (or factors that in turn affect morphology). As noted previously, none of the environmental variables are independent of each other, and so conclusions from the analyses of this study take this into account. Yet it is with the understanding of how each group of factors relate individually to morphological variation in the Americas that these future multivariate analyses may be appropriately applied using combinations of variables.

Chapter 5

IF I ONLY HAD A ____: ESTIMATION OF MISSING ELEMENT MEASUREMENTS

“THE OBSERVER WHO HAS THOROUGHLY UNDERSTOOD ONE LINK IN A SERIES OF INCIDENTS SHOULD BE ABLE TO ACCURATELY STATE ALL THE OTHER ONES, BEFORE AND AFTER.”

– Sherlock Holmes, The Five Orange Pips

Perhaps the greatest limitation to the usefulness of archaeological skeletal samples is the incidence of missing or non-measurable elements. As discussed in the “Archaeological Sample” section of Chapter 4 (Methods), there are a number of factors that contribute to the variability in preservation and use of archaeological human remains for research. The researcher may either choose to limit analyses to only those measurements that were observable at the time of data collection, or choose to estimate the measurements of the missing bones using the measurements from the available bones. The former choice is more statistically conservative, as the only error present is accountable measurement error, while the latter is subject to compounded error arising from measurement error and estimation error (which arises both from mathematical estimation uncertainty and from imprecision in measurement).

Missing measurement estimation is generally not regarded as necessary in most bioarchaeology studies; samples are often chosen to fit the criteria necessary to test proposed hypotheses. However, the estimation of missing element dimensions occurs in two sets of circumstances: 1) the comparison of a small, fragmentary sample with other, more complete samples, and 2) in the estimation of stature using an “anatomical” method (e.g., Fully technique) from skeletons missing a few elements. As the goal in data collection was to obtain as representative a sample of humans from across time and geography as possible, various groups were included despite their fragmentary preservation (e.g., the early Holocene

sample). Stature estimation and related morphological indices (i.e., relative sitting height, or relative limb length using complete lower limbs) are especially important to the hypotheses to be tested in this dissertation. Thus, though the sample has been chosen to test the posited hypotheses, the sample is not “ideal” for testing all hypotheses. It is therefore desirable to estimate missing element measurements when it is feasible.

Estimations of missing element dimensions have been employed for various samples, especially where most elements were available for direct measurement. Several methods are available for imputing missing values and for working with incomplete data (Allison, 2002; Little and Rubin, 2002). Of course, the most conservative method available is to use only the subset of the data that have all observations available, but as noted above and in Chapter 4, the nature of the osteometric data collected for this dissertation precludes this option. Using only the most complete skeletons would artificially bias the sample to geographic regions where taphonomic conditions and excavation techniques preserved skeletons in their entirety (Holt and Benfer, 2000). Many examples of methods for imputing missing data are found in the analyses of the fossil bones of human ancestors. For example, Asfaw et al. (1999) used a multiple-regression method to estimate missing long bone measurements from fragmentary remains. Another method is to determine the mean measurement of a dimension among observable cases in a sample, and use this mean as a “stand-in” for the missing measurement (Rhode and Arriaza, 2006). More complex methods also exist, such as modified expected maximization procedures (Schafer, 1997), bootstrapping of complete data (Little and Rubin, 2002), and various data exclusions based on listwise or pairwise deletions (Holt and Benfer, 2000).

All of these methodologies rely on the fulfillment of criteria associated with data missing at random (e.g., data are not systematically missing because of relative fragility of the element under consideration) or data missing in relation to other related variables (e.g., smaller bones or more gracile individuals will, by their nature, preserve fewer observable dimensions). In the case of data collected for this dissertation, most data missing from the data set are considered randomly-occurring, as the various factors influencing their preservation (see the “Archaeological sample” section of Chapter 4), though predictable, come about by chance. Often, data missing under these circumstances are imputed using the mean measurement for the dimension within a sample. Yet, some elements are more likely to be missing due to size and bone density (Galloway et al., 1996; see below), and therefore using sample means could artificially bias the “stand-in” measurements for missing data. Additionally, some elements have a positive allometry in relation to the size of the individual (some of which is examined in this dissertation). For these reasons, this dissertation employs other methods in the estimation of missing data values. The logic of estimating various measurements from throughout the skeleton is discussed in this chapter, with special attention devoted to those elements that compose the Fully technique for estimating statures (see the “Derived Morphologies” section of Chapter 4).

Despite the existence of a broad literature on estimating missing data, the accuracy and utility of missing element measurement estimations employed in anatomical stature estimation (i.e., the Fully technique) have not been studied extensively. Fully and Pineau (1960) developed equations for the estimation of the total vertebral column length using regions of vertebrae. Lundy (1985) devised a method for estimating individual vertebral heights as a percentage of total vertebral column length, using all other vertebrae in the

vertebral column as estimators. The downside of these two methods is their dependency on almost completely intact vertebral columns—which are rarely available in archaeological samples—for use as a reference sample by which to estimate the missing regions or individual vertebrae. Sciulli et al. (1990), in developing regression equations for stature estimation, used archaeological skeletons missing non-adjacent vertebrae. They approximated these missing vertebral heights by averaging adjacent vertebrae, which yielded results comparable to those of Lundy (1985), but did not depend on intact vertebral regions.

Auerbach et al. (2005) developed missing element equations for estimating all measurements used for anatomical stature reconstruction techniques. These were tested by estimating simulated missing elements from known elements and applying the revised Fully technique (Raxter et al., 2006); the resulting Fully stature estimations were then compared against the performance of mathematical method (multiple regression) stature estimations using the same known elements. With the exception of Fully technique reconstructions using estimated tarsals, tibiae or femora, multiple regressions always yielded smaller standard errors of the estimate and mean differences from actual skeletal statures¹.

For the analyses of this dissertation, a protocol has been developed for estimating missing measurements. The method for estimating measurements is based on the frequency of element absence, the necessity of measurements in analyses (i.e., some measurements are more informative in this study than others), and the presence of reliable measurements by which to make approximations. This section describes this protocol in detail, and the justifications for its use.

¹ Auerbach et al. (2005) also found that the cranial height (BBH) is not reliably predictable from any postcranial element dimensions or combination thereof. This has implications for morphological integration of the cranium and the postcranium, which is explored more extensively in the results of this dissertation.

5.1: Frequencies of missing elements

Table 5.1 presents the number of skeletons that I measured that had missing elements, and the percentage of the total sample lacking those elements. If any measurement was taken from an element, the element is *not* counted as “missing.” Specific measurements—namely length measurements—and regions of vertebrae are also listed in the table. For the purposes of this study, entire missing elements and elements not measurable due to trauma, pathology, or erosion were regarded equally; damaged or pathological bones effectively result in missing osteometric data.

On the whole, no more than one-third of the sample lacked measurements for most elements, though only in very few individuals (106) was every measurement possible. It is not a surprise that the smallest elements—manubria and cervical vertebrae—have the highest incidence of absent measurements. However, the data reported in Table 5.1 are not representative of the true occurrence of missing elements in archaeological samples. The incidence of missing limb long bones is artificially low, due to the selection criteria (see the “Archaeological sample” section of Chapter 4) for including skeletons in data collection. The only reason any skeletons are lacking these bones is because some were included in samples wherein other individuals with well-preserved post-crania lacked crania, or in rare, small samples, all measurements possible were taken (again, see the selection criteria listed in Chapter 4). Further discussion on the differential preservation of remains and the practical effects on sampling can be found in Chapter 4, and a number of other publications (e.g., Waldron, 1987; Galloway et al., 1996; Stojanowski et al., 2002).

5.2: Estimating missing element measurements

The incidence of missing elements in Table 5.1 allows for the assessment of

Table 5.1. Missing elements in the entire sample measured by BMA ($n = 2749$)

Element	Number missing	Percent missing
Calvarium ¹	664	24.2%
Face ²	645	23.5
Entire cranium (all measurements observable)	1355	49.3
Manubrium	1347	49.0
Clavicle	569	20.7
Cervical vertebrae (all present)	1498	55.5
C1	879	32.0
C2	922	33.5
C3	1013	36.8
C4	1003	36.5
C5	977	35.5
C6	880	32.0
C7	861	31.3
Thoracic vertebrae (all present)	1488	54.1
T1	809	29.4
T2	832	30.3
T3	842	30.6
T4	865	31.5
T5	852	31.0
T6	848	30.8
T7	827	30.1
T8	811	29.5
T9	801	29.1
T10	797	29.0
T11	843	30.7
T12	746	27.1
Lumbar vertebrae (all present)	1061	39.6
L1	690	25.1
L2	703	25.6
L3	727	26.4
L4	708	25.8
L5	661	24.0
Sacrum (total length and S1)	1223	44.5
S1	586	21.3
Bi-iliac Breadth ³	841	30.6
Humerus ⁴	225	8.2
Humerus maximum length	343	12.5
Radius ⁴	291	10.6
Radius maximum length	433	15.8
Ulna	423	15.4
Ulna maximum length	485	17.6
Femur ⁴	219	8.0
Femur maximum length	322	11.7
Femur bicondylar length	331	12.0
Tibia ⁴	291	10.6
Tibia maximum length	401	14.6
Tibia "Fully" length	435	15.8
Fibula	940	34.2
Talus and calcaneus	807	29.4

¹ BBH, GOL, EUB ² UFH, NAH, NAB, ZYB ³ Individuals with estimated BIB are not counted as missing.

⁴ Although the presence of these bones was a minimum requirement for inclusion of a skeleton in this study, individuals were included who had well-preserved crania in samples wherein most crania were unobservable.

commonly missing measurements, and therefore which elements would be subject to estimation from known measurements. Not all measurements are of equal utility or accurately approximated, and therefore have not been estimated using known measurements. Of those that are estimated, for example, femoral maximum length (FML) is used in determining intra- and interlimb indices, is employed in regression equations for mathematical method stature estimations, and is convertible to bicondylar length for inclusion in anatomical stature estimations. Given a known range of crural indices for a group, it is reasonable to estimate FML from known tibial length (Auerbach et al., 2005). Femoral head diameter (FHD), contrastingly, is important in estimating body mass, but cannot be easily estimated because: 1) body mass is highly variable within a population (Auerbach and Ruff, 2004), and so one would also conclude that femoral head diameter variance reflects this, and 2) the dimension is taken from an articulation, and so may be subject to the effects of behavior (Auerbach and Ruff, 2006; DeLeon and Auerbach, 2007), therefore making it difficult to accurately estimate despite high correspondence with distal femoral articulation breadths (FEB and FAB). (For example, the correlation of FHD to FAB is $r = 0.877$, but the %SEE of predicting FHD from FAB is 4%—or 1.7 mm—which is well above measurement error for FHD). Femoral average diaphyseal diameter would be even more poorly estimated, as this dimension strongly reflects individual activity (Ruff, 1991; Trinkaus et al., 1994), and therefore even a group-specific regression equation would be prone to high amounts of estimation error.

The following section describes the methods for estimating missing elements employed in this study, and the justification for the use of the method. Some additional methods are described, though not utilized. Preference is given to estimations for measurements that are

used in the revised Fully anatomical stature estimation technique, as developing stature estimation equations for American groups and inter-group comparisons using stature are goals in this dissertation. In all instances, missing elements are “simulated” from skeletons in which those measurements were taken, so that the estimated measurements could be compared with the known measurements.

5.2.1: Cranium

Measurements of the skull are not estimated in this study. Cranial dimensions have been estimated from each other, based on the functional relationship of facial form and cranial shape (Corruccini, 1972; Enlow and Hans, 1996; Bookstein et al., 2003). However, previous studies have cited a decoupling in facial and cranial shape variation (Cheverud, 1982), and low integration within the face (Polanski and Franciscus, 2006), which would suggest that any attempt at estimating missing cranial measurements would risk high amounts of error. Furthermore, individual variation in cranial dimensions, arising from environmental factors (such as diet; Marriog and Cheverud, 2001) and genetic variation (Cheverud, 1982) precludes the estimation of any cranial dimension from a multiple regression equation based on the means of other individuals, even a group of related individuals. This is borne out by examining correlations among the seven craniometrics utilized in this study, none of which have r^2 values over 0.30. Furthermore, as an example, using a stepwise multiple regression to estimate basion-bregma height (BBH) from the six other cranial measurements, the most useful predictors are (surprisingly) bi-zygomatic breadth (ZYB) and glabella-opisthocranium length (GOL), though these only have a r of 0.437, and produce a %SEE of 4.5% (much larger than the measurement error of 0.6% for BBH).

As noted above, preference is given to estimating measurements used in the Fully stature estimation technique. BBH may not be estimated from other cranial measurements, but it may be possible to estimate it from other post-cranial measurements, especially others associated with stature reconstruction. A multiple regression employing all other Fully measurements (vertebral heights, FBL, TFL and TCH), however, produces a poor estimation of BBH ($r = 0.457$, %SEE = 4.52%). This is equally as imprecise as the multiple regression using craniometrics. Therefore, the estimation of BBH from any other osteometrics is not practical.

5.2.2: Axial skeleton

Manubrium

The intraclavicular notch breadth (JNB) is a highly variable measurement; 1409 skeletons preserved this measurement, in which JNB ranged between 14.4 mm to 39.4 mm. Clavicular maximum length (CML) is the most proximate “breadth” measurement, and the clavicle is functionally related to the manubrium. However, correlations between CML and JNB are low ($r < 0.40$), and no other measurements in the skeleton are logical estimators. Given that JNB is only used in one derived morphology (see Methods “Derived Morphologies” section), no attempt has been made to estimate missing values for this measurement.

Vertebral heights

As they make up, on average, 31.7% of the total skeletal stature, and are also necessary in determining relative body proportions, the estimation of missing vertebral heights—if possible—is important. Unfortunately, as noted earlier in this chapter, vertebrae are among the most commonly missing bones in the archaeological sample. Three general methods

exist for estimating vertebrae: taking the mean of vertebral heights of vertebrae adjacent to the missing vertebra, deriving vertebral height as a percentage of the complete vertebral column length, and developing a multiple regression formula for estimating missing elements.

In order to assess the applicability and accuracy of these methods, the subset of the complete sample that possessed complete vertebrae ($n = 785$, 432 males and 353 females) was used. Despite potentially significant differences in the relative length of the vertebral column to the rest of the skeleton, it is important and interesting to note that the relative heights of vertebral elements to the complete vertebral column do not differ significantly among groups. Combining various groups for these analyses is justified. For all instances, the missing vertebrae or vertebral regions were simulated, methods were developed using the remaining vertebrae to estimate the “missing” measurements, and the resulting estimations were then compared with the actual measurements using paired t -tests and OLS regressions.

Sciulli et al. (1990) employed the estimation of missing vertebral heights from existing adjacent vertebrae. This method is logical, as vertebral heights generally increase inferiorly, but is also limited because it assumes a serial equal linearity in vertebral height increase. That is, it assumes that all vertebrae are of increasing and intermediate heights relative to the adjacent inferior and superior vertebrae. Though this is the trend for most vertebrae, there are important exceptions. Table 5.2 reports the mean vertebral maximum heights for all vertebrae, and Figure 5.1 shows the mean male and female maximum vertebral heights for C3 to L5. The element C2 is not shown in Figure 5.1, as it is considerably taller than the other vertebrae with a mean height of 35.54 mm, and C1 is likewise left off the figure, as its height is contained within the height of C2. Note that most of the thoracic vertebrae and the

Figure 5.1. Mean vertebral maximum heights

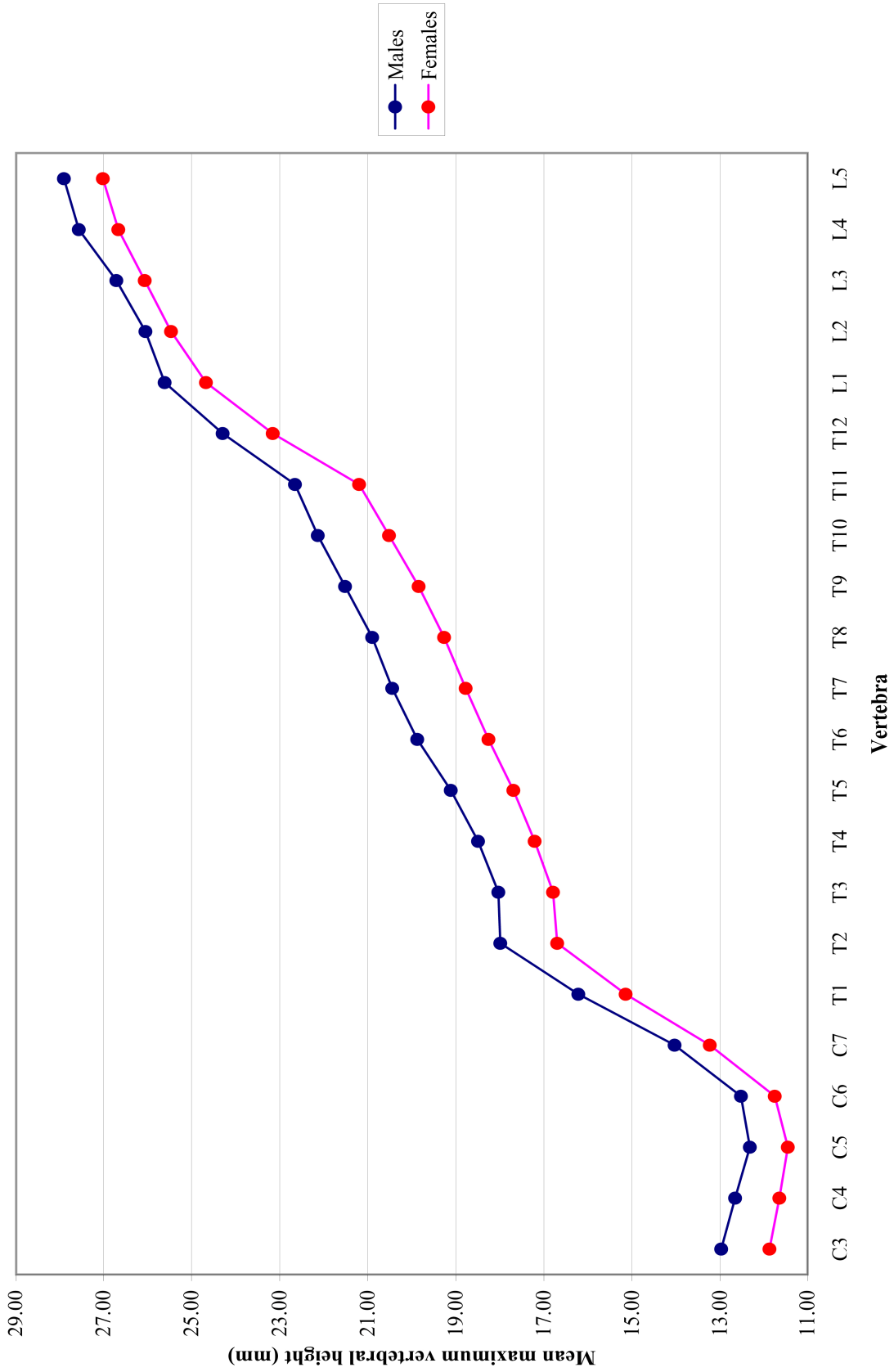


Table 5.2. Mean maximum vertebral heights and mean estimation errors of estimations using the mean of adjacent vertebrae

Vertebra ¹	Mean Maximum Centrum Height (mm)			Mean estimation error, all individuals (mm) [Std. Error] ²
	All (860)	Males (486)	Females (374)	
C1	10.67	11.12	10.11	N/A
C2	35.69	36.97	34.12	N/A
C3	12.48	12.97	11.88	N/A
C4	12.21	12.66	11.65	-0.003 [0.024]
C5	11.94	12.32	11.46	-0.257 [0.023]
C6	12.18	12.53	11.76	-0.624 [0.022]
C7	13.67	14.03	13.23	-0.285 [0.023]
T1	15.73	16.22	15.14	0.193 [0.023]
T2	17.41	17.99	16.70	0.804 [0.023]
T3	17.48	18.03	16.79	-0.187 [0.022]
T4	17.92	18.49	17.21	-0.059 [0.020]
T5	18.47	19.11	17.69	-0.057 [0.021]
T6	19.15	19.87	18.26	0.063 [0.023]
T7	19.69	20.44	18.78	0.039 [0.022]
T8	20.16	20.90	19.27	-0.064 [0.022]
T9	20.76	21.51	19.84	-0.023 [0.021]
T10	21.41	22.13	20.52	0.025 [0.025]
T11	22.00	22.65	21.20	-0.597 [0.033]
T12	23.78	24.30	23.16	0.191 [0.030]
L1	25.19	25.61	24.67	0.405 [0.029]
L2	25.78	26.05	25.47	-0.018 [0.029]
L3	26.42	26.71	26.06	-0.053 [0.031]
L4	27.16	27.56	26.66	0.194 [0.033]
L5	27.50	27.90	27.01	N/A

¹ Bolded vertebrae indicate vertebral heights that are able to be estimated reliably from the average of adjacent vertebral heights

² Shaded cells indicate vertebral heights with estimation errors within measurement error for the dimension.

lower lumbar vertebrae do increase at a nearly equal interval proceeding inferiorly. There are significant unequal intervals, however. The greatest changes in the cervical region occur between C2 and C3, and between C6 and C7. Also, C5 is shorter than both its inferior and superior vertebrae, because vertebral centra heights decrease in the cervical region and then begin to increase at the base of the neck as the vertebrae transition into the thoracic region. Among thoracic vertebrae, the height of the centrum of T2 is not intermediate between those of adjacent vertebrae, and neither is the height of T11. L1 centrum height is, on average,

slightly greater than the intermediary value between T12 and L2, likely due to the transitional nature of this region.

These exceptions prevent the application of Scullin's solution on these specific vertebrae, even when adjacent vertebrae are present. Table 5.2 reports the mean estimation errors for vertebral maximum heights estimated using adjacent vertebrae. Mean estimation errors with shaded cells in the table indicate estimations that are within measurement error, and so are appropriate for the application of the averaging technique. C2, C3, and L5 are not candidates for estimation. L5 does not have two adjacent vertebrae to be averaged (L4 and S1 are adjacent, but L5 is not intermediate between them in height), C2 is considerably taller than C3 and C1 (and estimations using C1 are not possible because of linear dependence), and C3, as noted above, is not intermediary in height between C2 and C4. Other vertebrae—C5, C7, T1, T3, T12, and L4—have estimation errors greater than measurement errors for those dimensions, but their estimation errors are smaller than 1/3 of a millimeter. As these are biologically negligible errors, it was decided to allow for the estimation of these elements from adjacent vertebrae. The remaining vertebrae—namely C6, T2, T11, and L1—cannot be estimated using the averaging method; their mean estimation errors are close to or greater than 0.5 mm, which is far greater than any measurement error. Given the transitional locations of these vertebrae, in addition, other methods are necessary to estimate them.

One alternative approach is Lundy's (1985) method, wherein each vertebra centrum height's mean percentage of total vertebral column length is determined, and then applied to determine the height of a missing vertebral centrum height (X_E). This can be summarized by the following equations:

$$\%X = \frac{X_K}{V_T}$$

$$X_E = \left(\frac{V_K}{100 - \%X} \right) - V_K$$

Where X_K is the known vertebral height, V_T is the known total vertebral column length, $\%X$ is the percent of total vertebral column length made by X_K , and V_K is the total vertebral column length without the missing vertebra. $\%X$ is calculated for an entire sample and then applied to individuals with missing vertebrae in need of estimation (X_E).

This method was tested on the vertebrae not estimated using the averaging technique (C2, C3, C6, T2, T11, L1, and L5). No significant sex difference was found in the percentage of the vertebral column constituted by these vertebrae. In two instances—C3 and C6—the resulting estimates were not statistically significantly different from the actual vertebral centra heights (C3: $p=0.944$; C6: $p=0.722$). The mean difference between the estimations and actual measurements of the other five vertebrae ranged from -0.51 to -1.97 mm. This technique, then, performs poorly as a means of estimating missing vertebral measurements compared to measurement error for these vertebrae. Moreover, its application is dubious; the method requires that all vertebrae *except* the missing vertebra are present. In order to keep a simple missing element estimation methodology, and to minimize compound error in using estimated measurements, Lundy's method has not been used on any vertebrae in this study.

Estimating the heights of these other vertebrae relative to the heights of adjacent vertebrae is another option. One method is to examine the percent position of these vertebrae relative to the height difference between their superior and inferior vertebrae. Averaging adjacent vertebrae to estimate a missing vertebral height assumes that the intermediate vertebral centrum height is close to halfway (i.e., 50%) between the heights of the vertebra superior and the vertebra inferior to it. As noted, C3, C6, T2, T11, and L1 are not equidistant

in height between their adjacent vertebrae. Table 5.3 presents the mean height of these vertebrae, in terms of a percentage of the height difference of the superior and inferior vertebrae. This is termed the “percent position.” For example, C6 has an incremental height close to 20% of the total height difference between C5 and C7; hence, this is why averaging C5 and C7 tends to overestimate the height of C6. These percent positions were calculated as:

$$\frac{X_S - X_E}{X_S - X_I}$$

Where X_S is the height of the superior vertebral centrum height, X_E is the height of the vertebrae to be estimated, and X_I is the height of the inferior vertebra. Taking the mean of all of the percent positions, this number was then multiplied by the absolute value of $X_S - X_I$, the answer of which was then subtracted from X_S to give the estimated height of the missing element. The resulting estimates are more accurate than those obtained using the assumed percent position of 50% (Table 5.2), and the method is, in addition, applicable to C3. Yet, the percent standard errors of the estimate are still somewhat high, as is mean measurement difference for the lower vertebrae. This indicates that there is some variation in the percent position of these vertebrae between their adjacent vertebrae, and that the distribution may be skewed. As this solution is somewhat complicated and cannot be applied to C2 and L5, so it is not used in this study.

An alternative would be to calculate the heights of missing elements as a percentage of the vertebral height of either the superior or the inferior vertebra. In these cases, the ratio of the vertebral centrum height to the superior or inferior vertebral centrum height was calculated as a percentage (reported in Table 5.3), and then the mean percentages were used

Table 5.3. Position of vertebrae, based on height, that do not fall close to 50% of the height difference between adjacent vertebrae, and heights relative to superior and inferior vertebral heights

Estimated vertebra	Mean percent position relative to height difference between superior and inferior vertebrae	Mean difference between height estimated using percent position and actual height (mm) (%SEE)	Percentage of mean vertebral centrum height relative to superior vertebral centrum height ¹	Percentage of mean vertebral centrum height relative to inferior vertebral centrum height ¹	Mean difference between actual height and best-performing height estimated as a percentage of adjacent vertebrae ¹ (%SEE)
C2	N/A	N/A	N/A	287.79%	-0.234 (8.71%)
C3	98.89%	0.017 (9.93%)	35.03%	102.44	-0.009 (6.45)
C6	19.64	-0.096 (9.15)	102.35	89.18	-0.015 (5.33)
T2	122.19	-0.450 (7.66)	110.80	99.71	-0.014 (4.31)
T11	23.21	0.740 (8.16)	102.86	92.58	-0.027 (4.48)
L1	68.83	0.781 (6.29)	106.03	97.76	-0.022 (4.13)
L5	N/A	N/A	101.36	N/A	0.000 (5.34)

¹ Best-performing estimator is in bold text

Table 5.4. Best performing multiple regression equations estimating missing vertebral heights not estimated by averaging adjacent vertebrae

Estimated vertebra	Most effective estimator vertebrae	Number of applicable cases in total sample (n=2749) [number included estimated ¹]	Estimation equation (all known measurements in mm)	Mean difference between estimated and actual height (mm)	SEE (%SEE)
C2	C3, C7	106 [115]	0.813(C3) + 0.666(C7) + 16.426	0.0068	2.220 (6.22%)
C3	C2, C4, C5	82 [96]	0.070(C2) + 0.570(C4) + 0.254(C5) + 0.005	-0.0112	0.742 (5.95)
C6	C5, C7	70 [72]	0.439(C5) + 0.460(C7) + 0.653	-0.0016	0.611 (5.02)
T2	T1, T3, T6	46 [49]	0.434(T1) + 0.435(T3) + 0.121(T6) + 0.650	0.0117	0.632 (3.63)
T11	T9, T10, T12	101 [113]	0.182(T9) + 0.395(T10) + 0.344(T12) + 1.591	-0.0090	0.894 (4.06)
L1	T12, L2, L3	38 [51]	0.425(T12) + 0.381(L2) + 0.143(L3) + 1.488	-0.0088	0.803 (3.19)
L5	L3, L4	60 [73]	0.241(L3) + 0.685(L4) + 2.546	0.0105	1.250 (4.55)

¹ Includes vertebrae that are estimated using the averaging of adjacent vertebrae

to calculate the height of the simulated missing vertebrae. For example, the centrum of C2 is, on average, 287.79% of the height of the centrum of C3. C3, C6, T2, T11 and L1 were estimated using both the superior and inferior vertebrae, and the more accurate estimator was selected (Table 5.3). C2 could only be estimated from C3, and L5 only from L4. When using this method, the mean differences between the estimated vertebrae and the actual vertebrae were considerably smaller than the percent position method described in the preceding paragraph.

One final option for estimating the heights of individual vertebrae is by using a multiple regression formula, estimating the height of missing elements based on those of known vertebrae. Various permutations of these formulae could be devised, so a stepwise regression was used to determine which vertebrae served as the most useful predictors of the seven vertebrae not estimated using the average of adjacent vertebrae. The resulting best equations are presented in Table 5.4. On the whole, these equations yield the most accurate method for estimating missing vertebral height measurements, especially for these seven vertebrae, but their application to the sample is rare. Even where estimators in the multiple regression equations that are themselves estimated were permitted (e.g., a T6 estimated using the averaging of adjacent vertebrae, which is then used to estimate T2), risking compounded error, there are very few instances in which the multiple regression equations may be employed. Therefore, the method in which vertebrae are calculated as a percent of an adjacent vertebra's centrum height (Table 5.3) has been applied in estimating C2, C3, C6, T2, T11, L1 and L5 when possible, even though it is slightly less accurate than the multiple regression method.

All of these preceding methods are applicable for the estimation of single vertebrae, and generally assume a vertebral column that is mostly intact. As shown in Table 5.1, though, at least one third of the sample is lacking complete regions of vertebrae, with cervical and thoracic vertebrae more commonly missing or unobservable. Thus, methods are also needed for estimating regions of the vertebral column length in the absence of multiple vertebrae.

As established above, regression formulae have the potential for estimating missing measurements with some accuracy. Skeletons hardly ever possess all thoracic vertebrae while missing multiple lumbar vertebrae (there are none like this in the overall sample), so a requirement for any of the following vertebral region or column length estimations is that an intact lumbar region be present. Also, based on the total archaeological sample, the frequency with which cervical regions are fully intact but there are multiple thoracic vertebrae missing is equally uncommon (again, no skeletons meet this criterion). Using these observed trends as guides, three methods for estimating vertebral column length with missing cervical and thoracic vertebrae were tested: estimating cervical vertebrae from intact thoracic and lumbar regions, estimating the total vertebral column length from intact thoracic and lumbar regions, and estimating the total vertebral column length from the intact lumbar region alone. In all instances, in order to avoid compound error, only non-estimated vertebral heights were incorporated.

Table 5.5 reports the equations and performance of regression methods for estimating missing vertebral regions. No significant sex difference was found in the proportions of total vertebral column length that each vertebral region constitutes, so all formulae were calculated using combined sexes. In the instances in which multiple cervical vertebrae are missing, the equations using both thoracic and lumbar vertebral regions as estimators

Table 5.5. Regression formulae for estimating missing section or total vertebral column length

Estimated vertebral section	Estimator(s)	Applicable cases in sample (n=2749)	Estimation equation (all known measurements in mm)	SEE (%SEE)	Mean difference between estimated and actual column length (mm)	95% confidence intervals	
						Lower	Upper
Cervical	Thoracic and lumbar sections	370	$0.295(\text{Thoracics}) + 0.179(\text{Lumbars}) + 5.481$	4.860 (4.95%)	-1.39 ¹	-2.29	-0.49
Vertebral column *	Thoracic and lumbar sections	370	$1.279(\text{Thoracics}) + 1.072(\text{Lumbars}) + 22.024$	12.814 (2.77%)	-0.75	-0.97	0.82
Cervical & thoracic	Lumbar section	318	$1.639(\text{Lumbars}) + 114.481$	18.544 (5.61%)	-0.034 ¹	-1.33	1.26
Vertebral column *	Lumbar section	318	$2.639(\text{Lumbars}) + 114.480$	18.644 (4.03%)	-0.033	-1.33	1.26

¹ This is the difference between the total actual vertebral column length and the vertebral column length determined from estimated section(s) and the known (estimator) section(s).

* Preferred method.

perform significantly better than those using just one of these regions (not shown in the table). Two options were tested in the case of missing cervical vertebral regions: (1) estimating the cervical region, and adding it to the known thoracic and lumbar region measurements to determine the complete vertebral column; (2) estimating the entire vertebral column length from the thoracic and lumbar regions. As evident from results in Table 5.5, the latter method (2) yielded more accurate estimations, with a smaller standard error of the estimate (SEE) and confidence intervals that are not negatively skewed. This method is preferred for the cases in which multiple cervical vertebrae are missing that cannot be estimated individually (e.g., if consecutive adjacent vertebrae are missing). In the case of missing thoracic and cervical regions, two similar approaches were tested using the lumbar vertebral region as the estimator. Again, the regression equation estimating complete vertebral column, rather than the missing region, performed more accurately. In this case, however, the difference between the two options is more marginal; only in the standard errors of the estimate are there differences, mostly because in the first equation, the error is for a smaller total measurement (thoracics and cervicals, as opposed to the entire vertebral column). Despite this minor difference, the equation estimating complete vertebral length from the lumbar region is favored.

In summary, the following protocol was used for the estimation of missing vertebrae:

- In the case of missing C4, C5, C7, T1, T3-T10, T12, and L2-L4 vertebrae, the vertebral heights of these vertebrae are estimated from the average of adjacent superior and inferior vertebrae if these vertebrae are present.

- When the necessary estimator vertebrae are present, C2, C3, C6, T2, T11, L1 and L5 are estimated as the percentage of the height of an adjacent vertebra, as indicated in Table 5.3.
- In cases wherein the previous two options are not possible, total vertebral column length is estimated using the regression formulae described in Table 5.5. Equations for estimating regions of vertebrae (as opposed to the entire vertebral column) are not used.
- Should skeletons not have intact lumbar vertebrae regions, or require multiple estimations to reconstruct vertebral column length, no estimation is attempted. For example, if a skeleton had only L1, L2 and L4 vertebrae, no attempt at estimating complete vertebral column length was attempted; L3 was estimated by averaging L2 and L4, L5 was estimated from L4 (or a multiple regression formula using L4 and the estimated L3), and vertebral column length was estimated from a combined lumbar region in which two vertebrae are estimated. Obviously, this introduces “creeping error” into the estimation of the vertebral column length.

Sacrum and os coxae

The sacrum, though part of the vertebral column, has been reserved for discussion with the innominates. Most commonly, the distal portion of the sacrum was broken during observation, and, logically, if total sacral length were measured, S1 could also be measured. Given proximity, a multiple regression formula estimating missing S1 heights from lumbar vertebrae was tested. Using stepwise regression, the best formula for estimating S1 was determined from L1 and L5. However, this equation yielded a SEE of nearly 2 mm, four times the measurement error for S1. In addition, the height of S1 is highly variable relative to the length of the lumbar vertebral region ($r = 0.547$). Complete sacral length is even more

variable in relation to S1 ($r = 0.357$). For these reasons, no attempt has been made to estimate either S1 height or total sacral length from known measurements.

Bi-iliac breadth, as discussed in Chapter 3, is important for estimating body mass (Auerbach and Ruff, 2004) and for examining variation in body breadth in relation to climatic factors (Ruff, 2002). Given the importance of this measurement in assessing these, no attempt was made to estimate bi-iliac breadth. In a number of cases, as noted in the previous chapter under the “Measurements” section, the os coxae are not completely intact. (Most often, the pubis has broken off uni- or bilaterally.) Sacral auricular surface correspondence with the iliac auricular surface is generally good, especially in more mature individuals. When the ilia, sacrum, and a substantial portion of the ischia were intact, bi-iliac breadth was estimated at the time of measurement and noted as estimated. There is some error inherent in taking bi-iliac breadth without intact pubic symphyses, though this does not generally amount to more than a couple of mm when good sacroiliac correspondence exists (tested previously during data collection for the Goldman Dataset).

Only in the instance of Kennewick Man was a more extensive estimation of bi-iliac breadth applied at the time of measurement. Kennewick Man’s sacrum consists of three large fragments, one of which includes most of the right auricular surface and half of the first sacral vertebra (S1). The right os coxa, shattered into eight large fragments and found with a lithic point embedded in the iliac blade, had been virtually reconstructed and recreated by rapid prototyping as an intact model by Dr. David Hunt at the time of observation. Bi-iliac breadth was taken using three approximations. First, the width of the left ilium from the SI midpoint of the auricular surface to the lateral edge of the iliac crest was taken (47 mm) and added to the width of the right sacral fragment from the ala to the midpoint of S1 (90 mm).

This produces an estimate of a half bi-iliac breadth. Second, the intact left os coxa was placed on the osteometric board, with the pubis reattached. The anteroposterior plane of the pubic symphysis was oriented to be perpendicular to the board, and the measurement from the pubic symphysis to the lateral edge of the iliac blade was taken (143 mm, again a half bi-iliac breadth). Third, the right os coxa rapid prototype model was placed in the same orientation on the osteometric board as the left had been placed in the second method, and the sacral fragment containing the right ala and S1 fragment was articulated with the os coxa. The midpoint of the S1 was still present on the sacral fragment, so this was aligned with the pubic symphysis and the measurement was taken (141 mm, also a half bi-iliac breadth). The second and third measurements were nearly identical, and, when doubled, resulted in estimates that were different by only 4 mm. The added measurements from the first estimation technique were similar to those of the second and third (8 to 12 mm different when doubled). A final check was performed at the time measurements were taken, prior to calculating bi-iliac breadth from the half bi-iliac breadth estimates, in which the rapid prototype replica of the right os coxa, the left os coxa (with pubis reattached), and sacrum were all articulated in their relative anatomical positions (with the aid of two conservators). Pubic symphyses were articulated, and S1 was articulated with the auricular surface on the os coxae. The midpoint of S1 aligned with the sagittal plane of the public symphyses, so that the os coxae were placed in their correct anatomical positions. The distance between their tubercles was measured to be 284 mm. Thus, the bi-iliac breadth taken has been judged to be a good estimation of the measurement were the pelvis intact. For the purposes of this study, the average of these three estimations (281 mm) has been used.

5.2.3: Appendicular skeleton

Throughout the appendicular skeleton, as noted in the introduction to this chapter, most measurements are not candidates for estimation due to inherent properties of these bones. In almost all cases, were bone lengths measured, midshaft diameter measurements and some articular measures were also taken. In the few instances in which midshaft diameter measurements were not possible, no estimation was attempted. Diaphyseal breadth dimensions are weakly related to length measurements and inconsistently related to articular measurements (Biewener and Bertram, 1993, 1994; Ruff, 2003; Auerbach and Ruff, 2006; DeLeon and Auerbach, 2007), with r^2 values generally below 0.40. Even within limbs, diaphyseal breadth measurements of elements, though correlated, show a great amount of variance; for instance, in the lower limb, an r of only 0.41 exists between the average AP and ML 50% diaphyseal breadth of the femur and of the tibia, despite the loading these elements share. Finally, as diaphyseal breadth measurements are related to and used as indicators of activity, estimated measurements would be fallacious in examining group differences, given the amount of individual variation in these dimensions and the inaccuracy in their estimation. Articular dimensions were not assessed for estimation for many of the same reasons, despite higher correlations among them. (See the argument made on page 227 about femoral head diameters as an example.) Some articular measurements are highly correlated between elements contributing to the same joint (e.g., the elbow and the knee), but there is no utility in estimating these dimensions for this study.

The maximum lengths of elements, however, may be candidates for estimation. As suggested by various authors (Hallgrímsson et al., 2002; Auerbach and Ruff, 2006; DeLeon and Auerbach, 2007), the longitudinal dimensions of limbs may be closely integrated and/or

less subject to influences from the environment—with the notable exception of nutrition and health (Tanner et al., 1982; Takamura et al., 1988; Danforth, 1999; Bogin and Keep, 2002; Malina et al., 2004; this dissertation). Clavicular maximum lengths, however, may be exceptional in relation to humeral maximum lengths, as there is a contralateral asymmetry pattern for CML and HML (Auerbach and Raxter, in review). These elements may not be as integrated as humeri and radii, reflected in the correlation coefficients ($r = 0.71$, CML and HML; $r = 0.89$ RML and HML). Brachial and crural indices (Chapters 3 and 4) are hypothesized to be generally similar among all individuals within a circumscribed geographic group, and thus may be good indicators of group identity. This is, of course, related to hypotheses tested in this dissertation. Even though proximal element length (i.e., humerus and femur) may be estimated with some accuracy from distal element length (i.e., radius and tibia) in groups with known intralimb indices, and vice versa (Auerbach et al., 2005), the employment of such estimations cannot be performed for three reasons: 1) brachial and crural indices, though closely correlated among members of the same group, still exhibit intragroup variability that make estimation of missing proximal or distal elements subject to more than measurement error; 2) the devising of equations by which to estimate missing limb elements requires known intralimb indices within a group, which may not be known or may not be representative of the variation of the entire potential sample measured; and 3) the use of any estimated limb lengths in calculating intralimb indices is tautological, and would only serve to falsely reinforce the known mean intralimb indices for a group.

Even though the majority of measured dimensions cannot be estimated within the limbs, though, a few measurements may be reliably estimated:

Femur

Femoral maximum length (FML) and femoral bicondylar length (FBL) are highly correlated ($r = 0.998$), and therefore may be estimated from each other. In practice, this occurs extremely rarely in the sample used in this dissertation, given the selection criteria for inclusion of specimens. FML is always present if FBL has been measured: missing FBL measurements never occur bilaterally, only 13 skeletons are missing FBL with a measured FML for the left side, and 17 skeletons lack the measurement for the right side. For these few instances, however, the following equations are provided (FML estimation is provided for reference only):

$$\text{FBL} = 0.995(\text{FML}) - 1.557 \quad (n = 2440; \% \text{SEE} = 0.46\%)$$

$$\text{FML} = 1.000(\text{FBL}) + 3.597 \quad (n = 2440; \% \text{SEE} = 0.45\%)$$

Tibia

Like FML and FBL, tibial maximum length (TML) and the tibial “Fully” length (TFL) are highly correlated ($r = 0.989$). TML was always measured if TFL was also measured. The inability to measure TFL was more common than missing FBL when maximum lengths were available, but again never occurs bilaterally (66 skeletons lack TFL with measurable TML on the left side, and 62 skeletons have it for the right side). These equations were employed for these few instances (again, the second equation is provided for reference only):

$$\text{TFL} = 0.982(\text{TML}) + 2.686 \quad (n = 2344; \% \text{SEE} = 1.10\%)$$

$$\text{TML} = 0.996(\text{TFL}) + 5.164 \quad (n = 2344; \% \text{SEE} = 1.09\%)$$

Talus and calcaneus

Unlike the various problems inherent in estimating limb element dimensions from each other, there is no inherent paradigmatic reason for not estimating talocalcaneal height (TCH) from other measurements. Among the elements used in the estimation of stature using anatomical methods, only cranial BBH ($n = 854$) and vertebral heights (Table 5.1) are more frequently missing, so the estimation of TCH would be useful. As there is significant sexual dimorphism in this measurement (mean male TCH = 65.78 mm, $n = 993$; mean female TCH = 59.49 mm, $n = 836$), all calculations carried out are sex-specific. The most logical elements to use as estimators are the tibia and the femur, as these are part of the same functional unit (the lower limb), and have the highest correlations with TCH (though these are admittedly low, at $r = 0.524$ for males and $r = 0.464$ for females). The resulting multiple regression equations are not highly accurate estimators:

$$\text{Males: } 0.100(\text{FML}) - 0.018(\text{TML}) + 28.775 \text{ (SEE} = 3.35 \text{ [5.1\%])}$$

$$\text{Females: } 0.074(\text{FML}) + 0.004(\text{TML}) + 27.745 \text{ (SEE} = 3.26 \text{ [5.47\%])}$$

In practice, these equations yield a 95% confidence interval of -0.13 to 0.17 mm. However, given that these equations yield a %SEE an order of magnitude greater than measurement error, the use of these equations could lead to large misestimates of missing tarsal height. Thus, estimated TCH measurements are employed only in comparative, less conservative population stature comparisons, and not used in any limb or body proportions.

5.3: A final comment on estimated measurements

With the exception of vertebral heights estimated individually (i.e., using the averaging of adjacent elements or the multiple regression of specific estimator vertebrae), the methods

for estimating the measurements for missing elements described above exceed the known measurement errors for those dimensions. This emphasizes the variation inherent within the skeleton, even among dimensions in related structures. Furthermore, this hints at the high variance in morphology within groups that will be explored in the upcoming chapters.

Some remaining issues concerning the use of estimated missing element measurements will be covered in the Results (Chapter 6). For example, is the inclusion of missing vertebral regions in anatomical stature estimations more accurate than the stature estimation equations generated for samples in this dissertation? Other outstanding questions, however, are beyond the scope of this dissertation, such as what the relationship of estimator and estimated dimensions suggest about morphological integration and relative sensitivity of regions of the skeleton to environmental factors. This topic will be discussed from a different approach (using variance-covariance matrices), but it would be interesting to compare the results of both methodologies.

Summary of missing element estimation protocol used in this study

In summary, the following protocol for the estimation of missing element measurements has been explored and developed in this chapter, and will be applied in the data analysis of this dissertation:

- No cranial dimensions can be estimated from each other, or from any combination of post-cranial measurements. Estimating cranial dimensions from each other is prone to high amounts of error and risks tautology. If a cranium is missing, anatomical stature measurements are not possible.

- In the axial skeleton, only vertebral heights of C2 to L5 may be subject to reliable estimation. In the case of individual vertebrae, heights are estimated using the protocol described in detail previously and included in the primary (conservative) analyses. In the less conservative analyses, vertebral column lengths estimated from intact thoracic and lumbar regions or the lumbar region alone using regression formulae are utilized. No attempts to estimate manubrium breadth, sacral measurements, or bi-iliac breadth (except for Kennewick Man, estimated at the time of measurement) are made.
- Despite potentially useful methods for estimating long bone skeletal element lengths from each other, no method has been developed that prevents circular reasoning and results, especially for intralimb indices. The estimation of most other dimensions of the appendicular skeleton is not attempted, in general, due to high amounts of variance in these measurements, increased error, and lack of utility in analyses. The only exceptions are the estimations of talocalcaneal height (see below) and the “physiological” lengths of femora and tibiae from maximum lengths for these elements, which are applied to the few cases in which these measurements were missing, and are used in the primary analyses.
- Talocalcaneal height can be estimated, with some error, from a multiple regression equation with femur and tibia maximum lengths. This method is only used in the less conservative analyses, when total vertebral column length is also subject to estimation.
- In all instances, estimated measurements are *not* used in the estimation of other measurements. For example, estimated vertebrae are not used in the multiple regression equations for estimating vertebral column length. This is to ensure that compound error is reduced as much as possible.

Chapter 6

RESULTS

“RESULTS WITHOUT CAUSES ARE MUCH MORE IMPRESSIVE.”

– Sherlock Holmes, The Stockbroker’s Clerk

6.1: Preliminary considerations

This chapter is devoted to reporting the principal results for analyses comparing the derived morphologies computed from osteometrics with each other and with environmental and geographic factors. Summaries of the climatic and subsistence data themselves are also provided in this chapter. Initial analyses of the osteometric data focus on determining the general patterns of variation in morphologies using the principal osteological data set (POD), the sexual dimorphism in morphologies, and the relative amounts of variance and covariance in these. The analytical focus then shifts to consider the effects of external factors. First, the relationships of climatic variables and of geography with morphology are examined. The next section examines the relationship of morphological variation to subsistence, both with and without taking climate into consideration. Robusticity and asymmetry of limb bones, which reflect activity patterns, are examined separately in relation to subsistence. The results of this study, regarding variation in body proportions among samples across the Americas, are applied in the derivation of new stature estimation equations and the methods for their determination are outlined. Finally, special attention is given to examining morphology and variation among the skeletons of the early Holocene, and to placing morphological variation in the Americas within the context of world-wide variation, i.e., including the Old World. The earliest skeletons from the Holocene are considered separately (in section 6.6) because they are unique, and, as isolated skeletons, cannot be analyzed in the same manner as other samples (e.g., they are not sample “means” and are not candidates for most parametric tests).

It is important to realize that many statistical approaches are potentially applicable in analyzing these data, but only a few yield useful results. Given the number of statistical tests conducted in analyzing the data, this chapter focuses on those results that best address the specific questions put forth in the first three chapters. For example, as noted in section 4.6.3 of the Methods, the use of principal components analysis is one multivariate means of examining morphological variation. However, in attempting to apply this method, it was found to be unreliable and difficult to interpret; climatic data do not reduce to a single canonical variable, and the loadings of morphologies in canonical variables vary by sample and between males and females.

6.1.1: Biological versus statistical significance

A common complication to the analysis of biological data is the issue of biological versus statistical significance. Some tests may yield results that are statistically significant, but are effectively biologically without meaning. For example, the lengths of femora may be statistically different between two samples, but if this difference amounts to two millimeters, then there is no biological relevance. Conversely, because of statistical power issues, biologically relevant distinctions may be overlooked.

As noted in Chapter 4, a large total sample from a broad geographic range is essential in examining human morphological variation and its relationship to climate and subsistence. Also reviewed in that chapter were the factors contributing to the unequal nature of the samples available across time and geography, which is evident in the POD. Statistically, such a sample has two drawbacks: a high chance of making Type I errors due to the large sample size, and difficulty in applying parametric statistics to test differences among samples

with different sizes. The latter point has already been discussed in the Methods in Section 4.6. The former issue, though, beleaguers all biological studies, and is not easily resolved.

Two solutions may be used to address the issue of biological “significance.” A strict, statistically conservative criterion of statistical significance (e.g., a probability value of 0.01 or less) may be adopted, and all results that do not meet that criterion—and any trends that they would indicate—are regarded as non-significant and therefore nonexistent. The difficulty of using this method is that, in trying to prevent spurious significance in results, the approach will fail to identify results which are significant (i.e., Type II error). Alternatively, the focus of statistical examination could be on the trends of test results, with statistical significance regarded as strong support for the biological tendencies implicated. In this chapter, a compromise between these two approaches will be used: statistical results are always presented as strictly significant or non-significant, though when results present a pattern worth mentioning, regardless of p -values, the trend is reported as biologically *interesting*. Under this system, the results are presented so the reader may decide if the results are biologically significant, or defer to my interpretations in the Discussion chapter following this one.

There is one additional preambular clarification to the design of this chapter. Many of the statistics used in these analyses build on each other. For example, if some results are unclear, another test may be used to resolve the uncertainty. In order to justify the use of the latter test, however, some discussion of the initial test’s results may be necessary. Thus, some textual elements normally found in the Discussion chapter will be found in the results.

6.1.2: Data distributions

Almost all of the derived morphologies and osteometric measurements considered in the

principal osteological data set (POD) and extended osteological data set (EOD) were normally distributed as determined from a Levene's test. Therefore, in general observations of the total sample, parametric statistics apply. Cranial index in both sexes is positively skewed. This is likely due to the inclusion of deformed crania that were not obviously purposefully altered. In practice, crania with indices over a certain amount (e.g., 0.95) could be removed from the analysis, but this would be extremely questionable. Some crania may be naturally equivalent in anteroposterior and mediolateral diameter, and designating any cutoff would be arbitrary. As cranial index is the only proportion considered in these analyses that fails to be normally distributed, and because this is only due to minor positive skewing, normal parametric statistics will be applied to analyses of cranial index variation among skeletons in the total sample. Results from these analyses, however, will be treated more conservatively in the discussion.

In addition to cranial index, two other general categories of derived morphologies violate normal distributions: asymmetry and robusticity. Asymmetry values (directional and absolute), by their nature, are not normally distributed, and therefore are tested using the non-parametric methods described in section 4.3.4 and outlined by Auerbach and Ruff (2006). All of the humeral and femoral robusticity distributions have highly positively skewed. This implies that there are a number of outliers with relatively greater robusticity than the majority of the sample considered. It is interesting to note that the positive skew, and thus the number of outliers, is greater for males than for females. As this violates the assumptions necessary for parametric tests, analyses of robusticity are conducted using non-parametric tests.

Tables 6.1.1 and 6.1.2 present the number of POD and EOD skeletons with the available dimensions. These are given for the total sample and by sex. Note that the majority of these

Table 6.1.1. Available total sample with general morphology and cranial dimensions. Note that body mass includes skeletons from both the POD and the EOD.

	Dimension					
	Stature	Body mass	Cranial index	Cranial module	Facial index	Nasal index
Total	1030	2797	1546	1996	1872	1714
Males	570	1536	837	1072	1006	920
Females	460	1261	709	924	866	794
Samples ¹	64	94	74	92	90	88

¹ POD only. “Samples” refers to large, individual sites, or to regionally and temporally proximate aggregated sites.

Table 6.1.2. Available total sample with postcranial dimensions. Note that brachial, crural and interlimb indices, as well as bi-iliac breadth, include data from both the POD and EOD.

	Dimension						
	Upper body breadth	Brachial index	Crural index	Relative torso height	Relative upper limb / torso height	Interlimb index	Bi-iliac breadth
Total	1118	2618	2644	1238	1248	2405	1994
Males	603	1443	1456	679	681	1327	1070
Females	515	1175	1188	559	567	1078	924
Samples ¹	71	94	94	68	68	90	87

¹ POD only. “Samples” refers to large, individual sites, or to regionally and temporally proximate aggregated sites. Including samples from the EOD adds 16 samples to the total number of available sample means for body mass and for brachial, crural, and interlimb indices, as well as 1 additional sample to the sample means for bi-iliac breadth.

dimensions were obtained only for the POD; the EOD contributes to brachial index, crural index, interlimb index, and bi-iliac breadth. It is readily apparent from these tables that the number of individuals presenting each measurement is unequal.

For the purposes of some analyses—namely V/CV matrices—the skeletal sample was limited to those skeletons in which all measurements were available. As vertebrae are the

most commonly missing elements (see Table 5.1), stature has the smallest available sample, and therefore the greatest limitation in analyses considering only skeletons preserving all dimensions. Only 407 skeletons present all of these dimensions; this sub-sample is mostly comprised of skeletons from the arctic ($n=128$ from Regions 1 and 2), the Prairie and Southeastern U.S. ($n=118$ from Regions 4 and 5), the Great Plains ($n=50$), and the U.S. Southwest and California ($n=92$ from Regions 7 and 10). Not surprisingly, this sub-sample is also restricted mostly to samples from the last 1500 years (302 skeletons). If only eight of these dimensions are considered—the four cranial dimensions, intralimb indices, relative torso height, and bi-iliac breadth—the total available sample increases to 545 skeletons (305 males, 240 females). This sample distribution is adequate for testing the covariation of proportions (subsection 6.2.3, below).

In order to avoid the issue of unequal sample sizes of samples and of dimensions available, I employed sample means. As these represent the average morphology for a given group, these data are appropriate for assessing general sample distinctions. Sample means are also employed to examine between-sample variation without interference from within-sample variation, though its practical application is limited (see individual analyses). The number of samples with means available for each dimension is also listed in Table 6.1. Note that, though the amount of discrepancy among samples in the number of available dimensions is less than the inequality of samples when considering individual skeletons, there is still a considerable difference. For this reason, some caution is used in equating the results of various analyses, using either the total skeletal sample or sample means, as the representation of regions and time periods will vary depending on which morphology is under consideration.

In addition to the sample distributions for the morphologies under consideration, the trends for climate and for subsistence are explored in the following subsections. The climate data, as well as geography, are inherently not normally distributed. For example, the amount of precipitation in the Pacific Northwest is an order of magnitude greater than the rainfall in the U.S. Southwest. Log-transformations of these variables do not result in normal distributions. Therefore, there may be some statistical caution in the use of climatic data, but the parametric statistics used here are robust to this violation of the assumption of normality. By their nature, subsistence data and the breakdown of geography into regions are categorical data; parametric statistics are applicable with these data.

6.1.3: General climate trends across geography and time

The regional averages of mean annual temperature (MAT), mean low temperature of the coolest month (MNT), mean high temperature of the warmest month (MXT), and mean total annual precipitation (MTP) are reported, by time period, in Tables 6.2.1 through 6.2.4. All of these are based on the palynological and dendrological data obtained from previous studies.¹ All regions except the Great Plains, Ecuador, Pacific Northwest, arctic regions maintained mean annual temperatures between 10 and 20 degrees Celsius (Figure 6.1 on page 261). Most regions have generally experienced reductions in MAT during the last millennium, with the notable exceptions of the Great Plains, Great Basin, California, the Pacific Northwest, and the Western Plateau, all of which have had mild mean temperature increases. Most

¹ These temperature and precipitation values are unquestionably subject to error for reasons previously discussed in section 4.5. Namely, while the data used are based on instrumentally-collected values obtained during the last century, they have been applied to time periods for which the only widely available climatic records are based on pollen and tree rings. However, these corrections reflect the current evidence for paleoclimate, and so better reflect past conditions than the indiscriminant application of modern climate to archaeological locations. The numbers presented are not intended to show absolute climate, but they are a good indicator of the paleoclimate for each region. In some instances, some sites cannot be modeled due to a lack of palynological data; no attempt is made to estimate past climate in these instances.

Table 6.2.1. Mean annual temperature (MAT) (° Celsius), through time and across geography

Region ¹	Time Period (yBP)									
	10000-8000	8000-6000	6000-4000	4000-2500	2500-1500	1500-1000	1000-500	500-100		
Western Arctic (Region 1)				-3.22	0.45	-3.22	-2.18			
Central Arctic (Region 2)							-7.96			-7.39
Great Plains (Region 3)						4.89	6.35	7.72		
Prairie & Eastern Woodlands (Region 4)				15.72	12.89	11.97	10.43	10.40		
Southeastern U.S. (Region 5)	11.38	16.89	16.09	15.31	22.11	15.63	16.37	14.93		
Great Basin (Region 6)	8.22		9.61	9.61	9.61	7.50	10.49	11.36		
U.S. Southwest (Region 7)						13.22	12.72	10.56		
Pacific Northwest (Region 8)				7.70	7.70			9.52		
Western Plateau (Region 9)	10.11						8.46	9.86		
California (Region 10)			15.29	12.74	12.48	12.63	16.86	13.83		
South Texas (Region 11)					21.00	19.80	20.94	20.94		
Ecuador (Region 13)					25.31					
Peru (Region 14)					22.10	18.94	18.94	18.94		

¹ Note that there is no climate model available for Guatemala, and so it is not included in this table and analyses using climatic factors do not include dimensions obtained from the single sampled site there. These skeletons are analyzed, however, with geography and with subsistence.

Table 6.2.2. Mean high temperature of warmest month (MXT) (° Celsius), through time and across geography

Region ¹	Time Period (yBP)									
	10000-8000	8000-6000	6000-4000	4000-2500	2500-1500	1500-1000	1000-500	500-100		
Western Arctic (Region 1)				14.28	15.34	14.28	13.43			
Central Arctic (Region 2)							13.17			13.52
Great Plains (Region 3)						28.22	29.36			31.06
Prairie & Eastern Woodlands (Region 4)				34.28	32.04	30.89	30.00			28.86
Southeastern U.S. (Region 5)	30.49	36.78	35.06	33.45	32.72	32.30	32.06			31.89
Great Basin (Region 6)	26.50		33.59	33.59	33.59	30.11	33.02			33.72
U.S. Southwest (Region 7)						36.56	33.46			31.35
Pacific Northwest (Region 8)				17.44	17.44					19.78
Western Plateau (Region 9)	28.29						28.60			24.57
California (Region 10)			27.90	27.20	22.03	20.12	28.63			30.72
South Texas (Region 11)					34.86	36.48	30.94			30.94
Ecuador (Region 13)					32.00					
Peru (Region 14)					30.10	27.60	27.60			27.60

¹ Note that there is no climate model available for Guatemala, and so it is not included in this table and analyses using climatic factors do not include dimensions obtained from the single sampled site there. These skeletons are analyzed, however, with geography and with subsistence.

Table 6.2.3. Mean low temperature of coolest month (MNT) (° Celsius), through time and across geography

Region ¹	Time Period (yBP)									
	10000-8000	8000-6000	6000-4000	4000-2500	2500-1500	1500-1000	1000-500	500-100		
Western Arctic (Region 1)				-20.28	-12.93	-20.28	-16.72			
Central Arctic (Region 2)							-35.35			-34.65
Great Plains (Region 3)						-19.72	-17.32			-14.99
Prairie & Eastern Woodlands (Region 4)				-3.94	-7.30	-6.98	-10.00			-8.22
Southeastern U.S. (Region 5)	-7.96	-3.61	-3.84	-3.85	9.44	-1.89	-0.80			-2.97
Great Basin (Region 6)	0.61		-7.63	-7.63		-11.22	-9.37			-7.00
U.S. Southwest (Region 7)						-7.78	-6.15			-8.71
Pacific Northwest (Region 8)				0.06	0.06					0.90
Western Plateau (Region 9)	-3.28						-8.86			-2.28
California (Region 10)			1.64	1.48	3.52	4.46	5.44			1.28
South Texas (Region 11)					6.00	3.35	8.39			8.39
Ecuador (Region 13)					18.00					
Peru (Region 14)					9.74	12.10	12.10			12.10

¹ Note that there is no climate model available for Guatemala, and so it is not included in this table and analyses using climatic factors do not include dimensions obtained from the single sampled site there. These skeletons are analyzed, however, with geography and with subsistence.

Table 6.2.4. Mean total annual precipitation (MTP) (mm), through time and across geography

Region ¹	Time Period (yBP)									
	10000-8000	8000-6000	6000-4000	4000-2500	2500-1500	1500-1000	1000-500	500-100		
Western Arctic (Region 1)				37.80	98.45	37.80	60.14			
Central Arctic (Region 2)							31.68			28.00
Great Plains (Region 3)						48.19	44.58			38.58
Prairie & Eastern Woodlands (Region 4)				92.15	97.79	91.10	98.89			116.55
Southeastern U.S. (Region 5)	84.72	73.08	86.15	106.68	136.42	140.35	126.21			136.60
Great Basin (Region 6)	13.51		21.44	21.44	21.44	30.51	25.11			36.09
U.S. Southwest (Region 7)						47.22	31.33			32.37
Pacific Northwest (Region 8)				327.00	327.00					193.11
Western Plateau (Region 9)	19.02						26.34			33.84
California (Region 10)			19.96	75.58	48.50	30.37	26.29			116.59
South Texas (Region 11)					93.48	84.38	107.39			107.39
Ecuador (Region 13)					108.82					
Peru (Region 14)					6.75	19.70	19.70			19.70

¹ Note that there is no climate model available for Guatemala, and so it is not included in this table and analyses using climatic factors do not include dimensions obtained from the single sampled site there. These skeletons are analyzed, however, with geography and with subsistence.

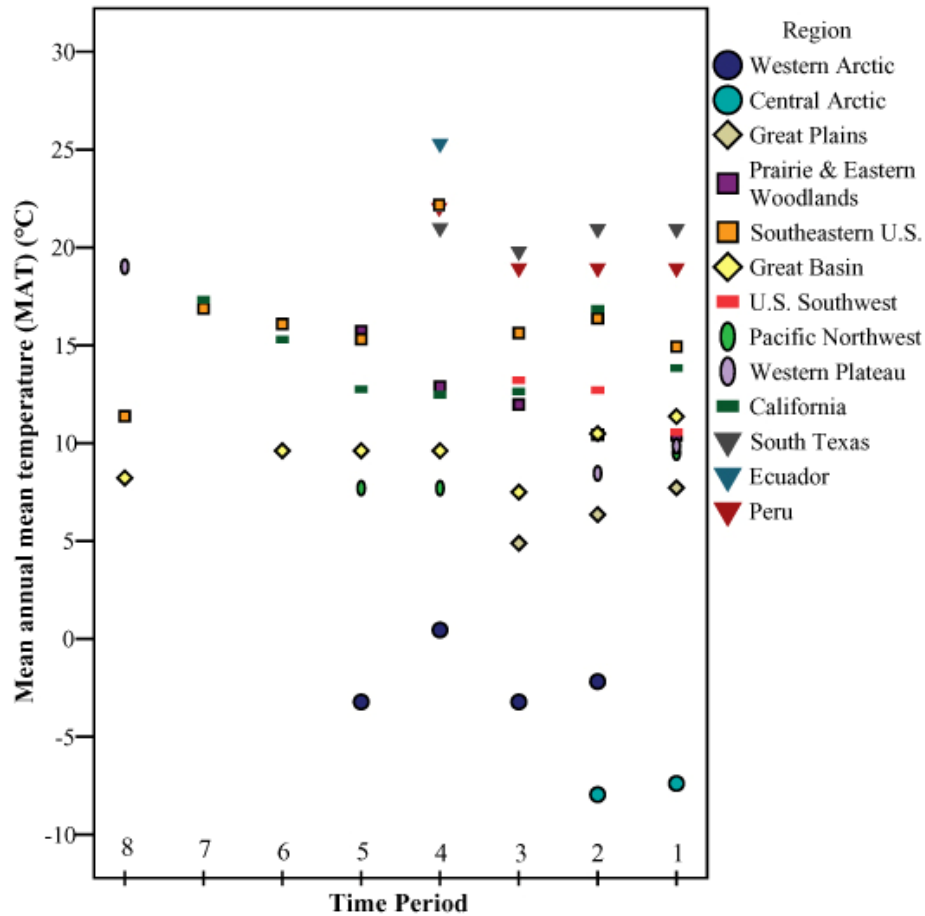


Figure 6.1. Regional mean annual temperatures (MAT) through time. Time periods: **8**, 1000-8000 yBP; **7**, 8000-6000 yBP; **6**, 6000-4000 yBP; **5**, 4000-2500 yBP; **4**, 2500-1500 yBP; **3**, 1500-1000 yBP; **2**, 1000-500 yBP; **1**, 500-100 yBP.

regions have also undergone increases in MTP. It is evident, however, that climatic trends over time are not the same among the geographic regions considered in the POD.

These trends reflect average climates within regions that, while geographically constrained, contain multiple microclimates. For example, the dramatic temperature “spike” apparent between 2500 and 1500 yBP in the Southeastern U.S. is an aberration resulting from sampling; whereas all other time periods considered in this region contain samples from multiple locations in the region (namely, Tennessee), this time period only has two samples from western Florida, where temperatures were considerably higher than in the Southeastern

U.S. sites sampled from before and after this time period. Thus, the patterns reported in Figure 6.1 and Table 6.2 mask the trends present within smaller areas of each region. However, the general regional trends reflect the presence of warmer temperatures during the mid-Holocene hypithermal (ca. 6000 yBP), as well as during the “Medieval Warming Period” approximately 1000 years BP, though the latter is most pronounced in the Great Plains, the Great Basin and California, and not clearly evident in some regions. The southern regions of the U.S. also show slight increases in MNT during this period, but not the MAT increases observed in the interior and western regions of central North America. These general trends do indicate that much of the variation in temperature over time may be attributable to fluctuations of the MXT more than those of the MNT. Statistically assessing these differences, however, is made difficult by the lack of long temporal continuity among sampled sites within a smaller area of each region.

One smaller area within North America, though, has samples that date from a nearly continuous time range: the Tennessee River Valley (Tennessee and Kentucky). Plotting MAT and MTP against time (Figure 6.2), the general trends reported for eastern North and mean total annual precipitation has increased. Note that MAT did increase and MTP decreased slightly during the Medieval Warming Period under this model. A series of Kruskal-Wallis tests comparing the MXT, MNT, and MTP in this river valley among three aggregated time periods (8000-4000 yBP, 4000-1500 yBP, 1500-100 yBP) indicates significant changes in all three climatic factors over time ($p < 0.01$). Mann-Whitney *U*-tests, comparing these factors among these three time periods, show that all three significantly differed from each other in MXT and MTP, and that the most recent time period (1500-100 yBP) has had significantly warmer MNT than the two earlier periods. The general trend of a

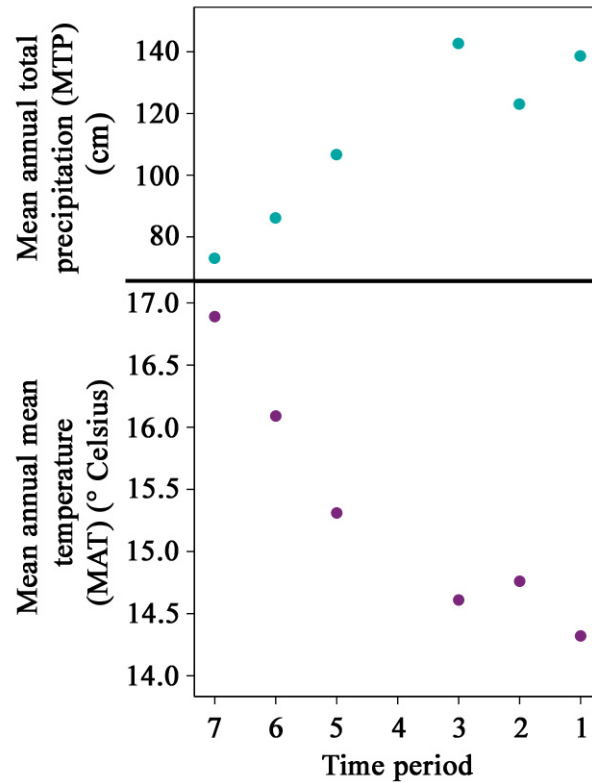
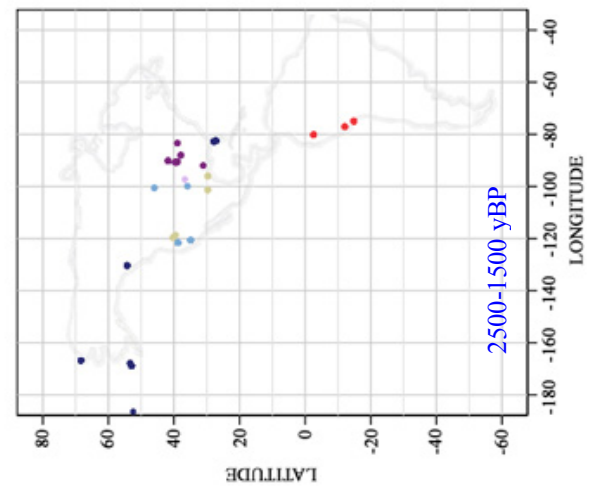
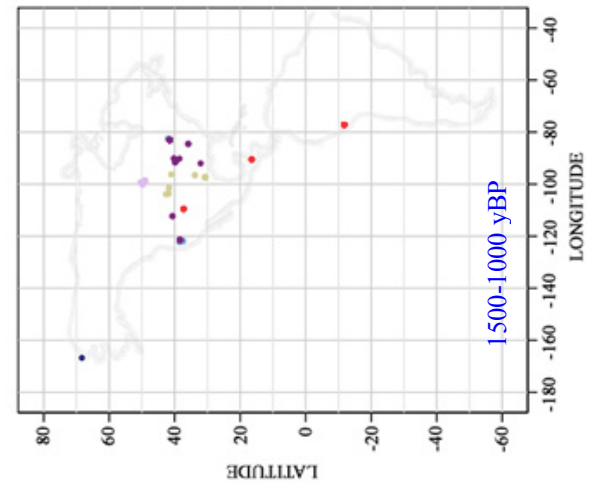
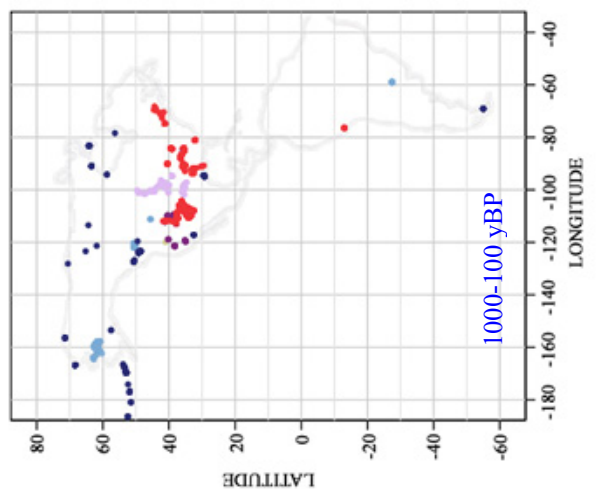
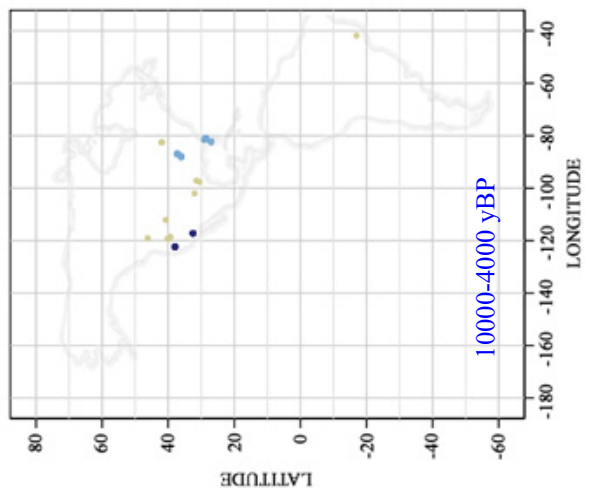
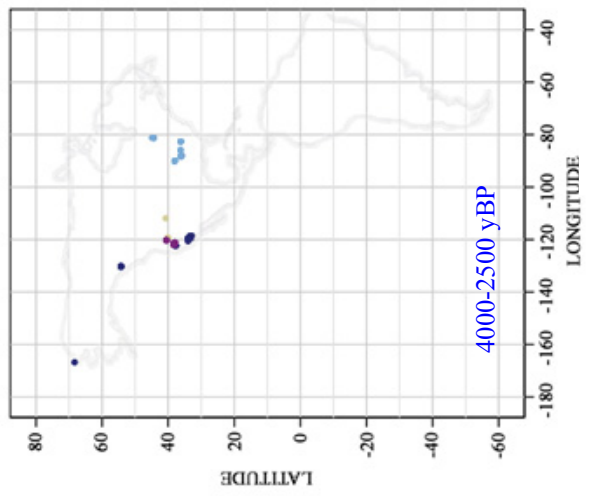


Figure 6.2. Average Tennessee River Valley mean annual temperature (MAT) and mean annual total precipitation (MTP) through time. Time period numbers correspond to the same periods as those used in Figure 6.1. No samples are available for time periods 8 and 4. America are supported: mean annual temperatures have decreased since the early Holocene,

cooler but wetter climate persisted over time, despite the indication for warmer temperatures during the winter. It is notable that the range between winter and summer temperatures decreased over time under this climate model, implying less extreme seasonality in this area of the Southeastern region during the last 1500 years.

Next page: Figure 6.3. Subsistence patterns across geography and time. These maps include samples from both the POD and the EOD. Dots indicate individual sites, and are color-coded to reflect the dominant subsistence strategy assigned to sites: gold, broad-spectrum hunter-gatherer; light blue, freshwater hunter-gatherer; dark blue, marine hunter-gatherer; purple, incipient horticulturalist; lavender, village horticulturalist/hunter; red, agriculturalist. Note that some time periods have been aggregated.



6.1.4: General subsistence patterns across geography and time

Like the trends for the climate data, patterns of subsistence vary considerably through time and among regions. Figure 6.3 presents these trends in maps of aggregated time periods and sites coded by subsistence strategy. Prior to 4000 yBP, only forms of hunting and gathering were practiced across the sample. Between 4000 and 2500 yBP, approximately two-thirds of the skeletons measured belonged to hunter-gatherer groups, while the remaining third were horticulturalists. The latter were located in central California, in the Sacramento River Valley. By the next time period—between 2500 and 1500 yBP—agriculture had appeared in South America, and samples located along the Mississippi and Illinois River Valleys had also developed forms of horticulture. In the next 500 years, agriculture was present in samples from the U.S. Southwest, horticulture was present throughout the Prairie and Southeastern U.S., and village horticulturalist/hunters (VHH) were found in the northern Great Plains. Finally, in the last millennium (the two most recent time periods), agriculture was found throughout the U.S. Southwest, the Mississippi, Illinois and Tennessee River Valleys, and into the northeastern Woodlands. VHH were found throughout the Great Plains, and horticulturalists persisted in California. Throughout all of these time periods, hunter-gatherers were living in the sub-arctic and arctic, and persisted in Southern Texas and southern California.

Although these patterns of subsistence are the products of cultural history (most notably, agriculture was not invented until the mid-Holocene), they are inexorably linked with climate and geography. For instance, agriculture is a practical impossibility in the arctic regions, and marine hunter-gatherers would not have lived on the Great Plains. Indeed, subsistence is significantly correlated with both geography and climatic factors. A Spearman's non-

Table 6.3. Spearman’s correlation coefficients: subsistence with geographic and climatic factors. Bolded numbers indicate factors that are significantly correlated with subsistence.

	Latitude	Longitude	Mean annual temperature	Mean high of warmest month	Mean low of coolest month	Mean annual total precipitation
Spearman’s ρ	-0.234	0.233	0.140	0.312	-0.075	0.025

parametric correlation (Table 6.3) clearly demonstrates this, as do the maps in Figure 6.3.

Note that precipitation is not significantly correlated with subsistence (possibly due to bias introduced from the Pacific Northwest), and the correlation with mean lowest temperature (MNT) is minor. In fact, mean highest temperature (MXT) has the greatest correlation with subsistence practices, though this correlation is admittedly not particularly high. The implications of these correlations have considerable consequences in the analyses of morphological variation in relation to climate and to subsistence, and will be discussed at greater length when subsistence and morphology are considered with each other.

6.2: General patterns of morphological variation after the early Holocene (<8100 yBP)

Patterns of morphological variation in the total POD sample are examined prior to considering the effects of climate and to subsistence. This is especially important in establishing morphological relationships that indicate underlying integration, as well as which dimensions are contributing to more of the variance in derived morphologies (e.g., radial length or humeral length in brachial indices). Specifically, this section considers variation in (non-deformed) cranial and postcranial morphologies, and the covariation of cranial and postcranial morphologies. An understanding of these fundamental patterns, in turn, will help inform the analyses of morphological variation in relation to environmental

factors. Two morphological traits—robusticity and asymmetry—are not considered in this section, as they are relevant only to comparisons among subsistence groups.

These analyses are conducted for the entire sample, and then are considered by aggregated time period.² In both sets of comparisons, tests are run first on the subset of the total sample in which all the morphologies are available, and then on the complete available sample. Discrepancies in regional representation between the two subsets of morphological data are reported. Early Holocene skeletons are not included in these analyses for the reasons described at the beginning of this chapter.

6.2.1: Cranial variation

General patterns and changes through time (combined sexes):

The four cranial derived morphologies—cranial index, cranial module, facial index, and nasal index—demonstrate considerable variation throughout the Americas. Comparing coefficients of variation (CV) among these in the total sample (excluding deformed crania), cranial module exhibits the least variability (CV=3.53%), while nasal index (CV=11.04%) has nearly twice the variability of cranial index (CV=6.22%) and facial index (CV=6.55%). The mean cranial index has increased through time, with a mean index of 74.12 between 10000 and 8000 yBP, and a mean index of 78.08 between 1500 and 100 yBP. A one-way ANOVA with a Games-Howell post hoc test shows that this trend is significant and suggests a temporal trend for increasing brachycephaly. Contrastingly, cranial module is significantly larger in groups living during the middle Holocene (4000 to 1500 yBP) (mean module, 151.06 mm) than any other temporal period in the Holocene, which do not significantly differ

² Unlike analyses with climate, time periods are aggregated in these analyses to provide large enough samples in temporal comparisons. Time periods are aggregated as follows: 8000 – 4000 yBP, 4000 – 1500 yBP, 1500 – 100 yBP. Admittedly, these are very coarse measures of temporal variation, but more defined temporal ranges are considered in the analyses with environmental factors.

from each other (means all round to 149 mm). Facial and nasal indices, while variable, do not show any temporal trends, and are not significantly different between the earliest and latest temporal periods. Examinations of these temporal differences in two regions that each include good temporal representation—California and the Southeastern U.S.—reveal the patterns for cranial index and module to be consistent when considered within regions.

Sexual dimorphism:

Table 6.4 shows the means, standard deviations, and percent sexual dimorphism in cranial derived morphologies. On the whole, these four morphologies exhibit some sexual

Table 6.4. Sex means and standard deviations of cranial morphologies using only individuals in the POD with all dimensions available (665 males and 579 females). Index values are percentages, whereas cranial module is expressed in cubic units. Sexual dimorphism percentages (SD%) are calculated from the means presented; sexual dimorphism significance tested using multiple independent sample Student’s *t*-tests. **Bold** text indicates significant sexual dimorphism ($p < 0.05$).

	Time period (yBP)	Cranial index		Cranial module		Facial index		Nasal index	
		Mean	Standard Deviation	Mean	Standard Deviation	Mean	Standard Deviation	Mean	Standard Deviation
♂	All	77.15	4.70	151.9	4.21	168.35	10.63	84.32	9.49
	1500-100	77.30	5.07	151.4	4.31	166.88	9.92	83.06	9.82
	4000-1500	77.39	3.84	153.0	3.97	169.51	11.64	86.01	8.81
	8000-4000	77.26	3.88	151.0	4.12	174.49	10.32	86.72	7.45
♀	All	78.39	4.90	146.5	4.41	168.46	11.12	88.08	8.89
	1500-100	79.00	5.32	146.0	4.33	167.56	11.57	87.74	9.31
	4000-1500	78.05	3.74	148.5	4.01	169.28	9.84	88.19	8.56
	8000-4000	76.50	3.44	145.1	4.24	169.82	10.34	89.73	7.46
Sexual			SD%		SD%		SD%		SD%
	All		-1.59		3.62		-0.07		-4.36
	1500-100		-2.18		3.63		-0.41		-5.48
	4000-1500		-0.85		2.99		0.14		-2.50
	8000-4000		0.99		3.99		2.71		-3.41

dimorphism using multiple independent Student's *t*-tests, although differences are greatest for cranial module and nasal index. In general, cranial module results indicate consistently larger male crania, which are not surprising, as cranial module is related to size. Females in all time periods have relatively wider nasal apertures, and relatively wider calvaria except for the most ancient samples. A MANOVA examining cranial morphology in relation to sex, while using region as a covariate, corroborates the results of the *t*-tests; the *t*-test results are not affected by the disproportionately greater number of geographic regions represented in more recent temporal periods (2 regions in the oldest period versus 13 in the most recent).

T-tests take variance into account in their calculation, and are robust against unequal sample sizes (namely by adjusting the degrees of freedom). However, it is interesting to examine the same morphologies using sample means for males and females. These *t*-tests reveal that cranial index is not sexually dimorphic, and nasal index is not dimorphic prior to 1500 yBP. Only cranial module remains sexually dimorphic (males having larger crania). As this method drastically decreases the degrees of freedom by an order of magnitude, some of these statistical discrepancies may be due to a loss of statistical power.

Some patterns of variation between males and females appear to change through time. Most striking are two temporal changes in sexual dimorphism in facial and nasal indices, both of which are caused by differences in these morphologies among males among time periods. Between the 8000–4000 yBP and 4000–1500 yBP periods, facial index in the male sample decreases substantially while remaining effectively constant among females. Similarly, between the 4000–1500 yBP and 1500–100 yBP periods, males exhibit a substantially larger decrease in nasal indices compared with females. Also, as indicated in the general temporal analysis, cranial module is slightly greater in the middle aggregated

time period for both sexes. As samples from geographic extremes (i.e., the arctic and South America) are not present in the oldest time periods, it is possible that some of these differences are affected by different sample compositions. However, sex-specific MANOVAs examining temporal periods in relation to facial and nasal indices, while making region a covariate, indicate that these temporal patterns remain significant.

Scaling and COVs for indices:

In examining variation among indices, attention should also be focused on the relationship of the measurements that determine these derived morphologies (i.e., between the numerator and the denominator). Table 6.5 shows OLS regression slopes, Pearson's r -coefficients, and standard errors of the estimate for components of each of the indices. Sex-specific linear regressions of log-transformed component measurements for each of the cranial indices (e.g., EUB and GOL in cranial index) reveal that there is a great amount of variation in the relationships between component measurements. Pearson's correlations in all cases are low ($r < 0.35$ in all instances), though the regressions yield significant results in all cases except for cranial index in both sexes. With low correlations between the measurements, however, the slopes of these regressions are sensitive to the line-fitting method chosen, and reduced major axis (RMA) regressions are likely inaccurate. Given the very low correlations, it may be reasonable to state that there is little relationship between the component measurements for any of the indices. Examining the scaling relationships is impractical for this reason³.

³ It should also be noted that any results obtained from analyses of relative scaling of the cranial components, were they possible, would be of questionable value. No paradigm for the expected scaling exists, and resultant differences in scaling could be due to inherent differences in the dimensions or are related to a third factor, such as increases in cranial (or body) size.

Table 6.5. Regression results of log-transformed component measurements for cranial indices. Asterisks indicate significant regression slopes. Note that the “Y” components (i.e., dependent variables) are the numerators from the indices.

MALES	Cranial index	Facial index	Nasal index
X/Y component measurements	GOL/EUB	UFH/ZYB	NAH/NAB
<i>n</i>	836	754	683
OLS regression equation	0.047x + 4.965	0.441x + 2.235*	0.274x + 2.496*
Standard error of the estimate	0.0425	0.0584	0.1007
Pearson’s <i>r</i>	0.048	0.316	0.211
FEMALES			
<i>n</i>	708	637	545
OLS regression equation	0.035x + 4.981	0.457x + 2.125*	0.320x + 2.288*
Standard error of the estimate	0.0452	0.0608	0.8815
Pearson’s <i>r</i>	0.035	0.314	0.272

Table 6.6. Coefficients of variation (CV) for cranial measurements (male *n* = 665; female *n* = 579). See Appendix II for measurement definitions. Asterisks indicate significantly higher variance than associated measurement(s) used in calculating morphologies, as determined by an ANOVA.

	Cranial dimension					
	GOL	EUB	UFH	ZYB	NAH	NAB
Males	4.08	4.47*	6.03*	4.33	10.17*	7.91
Females	4.49	4.46	6.45*	4.32	9.18*	7.69

This does not explain which dimensions contribute more to the variation observed in cranial morphology. Examining COVs (listed in Table 6.6), it is quickly apparent that the relative variation in neurocranial dimensions is similar for both sexes. The covariance of these factors, as implied by the regression results, is low. Perhaps the most striking observation here is that height dimensions contribute more to the variance in facial and nasal indices for both sexes. This is interesting, as previous studies have suggested higher variance in *breadth* rather than height for these morphological indices (Franciscus and Long, 1991).

6.2.2: Postcranial variation

As in the examination of cranial variation, general temporal trends, sexual dimorphism, scaling and relative variance in postcranial morphologies and measurements are investigated in this subsection. However, there are considerably more postcranial measurements and morphologies under consideration. Therefore, this section reviews basic patterns of postcranial variation in two groupings: indices and measurements of morphology (i.e., stature, body mass, and body breadth). General patterns are examined with sexes combined; all other analyses look at sex-specific trends.

General patterns and changes through time – indices (combined sexes):

The degree of variation among the postcranial proportions is, on the whole, less than the variability observed among crania. Crural index, surprisingly, has relatively little variation (CV = 2.92%), exceeding only interlimb index (CV=2.64%). In contrast, brachial index has more variation (CV=3.71%), though not as much as relative torso height (CV=5.23%), or relative upper limb length/torso height (CV=5.13%). As torso height is composed of multiple elements (17 vertebral heights), it is possible that at least some of this greater variability is attributable to the presence of more measurements (and therefore compounded by more variation in each dimension).

Unlike the temporal trends observed in the crania, there are no apparent changes over time in mean postcranial indices, except for the two related to torso height. Assessed by a one-way ANOVA, mean relative torso height appears to significantly increase over time (e.g., 46.90, at 8000–4000 yBP; 48.11, at 4000–2500 yBP), and, accordingly, mean relative upper limb length/torso height decreases from 150.05 at 8000–4000 yBP to 147.07 at 1500–100 yBP. Both of these trends are consistent with shorter limbs. Mean brachial, crural, and

interlimb indices, however, do not significantly change over time. Examined in the Southeastern U.S., which has the longest temporal representation of all the regions, these patterns break down. For example, mean crural index is significantly lower among samples dating between 1500–100 yBP compared with previous time periods, while mean brachial index does not significantly change over time. Over all temporal periods, however, the interlimb index significantly increases and then decreases again. Another study of these patterns in California, which also has a long temporal sequence of samples, reveals a pattern different from both the combined sample temporal comparison *and* the temporal variation observed in the Southeastern U.S. These incongruities imply that sample bias (namely, regional representation) is the cause of the apparent temporal trends in torso height. This, in turn, has important implications for analyses of temporal variation in relation to environmental factors.

General patterns and changes through time – morphology (combined sexes):

Relative to postcranial proportions, the other derived postcranial morphologies have more inherent variation. Stature varies as much as relative torso height (CV=5.23%). Upper body breadth (CV=7.87%) has more variability than bi-iliac breadth (CV=5.73%). Finally, body mass has the greatest amount of variability of any morphology considered (CV=13.08%).

Like the one-way ANOVA analysis of postcranial indices, temporal patterns are inconclusive for these morphologies. Although mean stature has increased over time (156.87 at the oldest aggregated time period to 158.10 in the most recent aggregated time period), it has not changed significantly. In contrast, both mean body breadths and mean body mass (which are intrinsically related) all experience significant increases between the 8000–4000 yBP and 4000–1500 yBP time periods, and then a slight, significant decrease during the

1500–100 yBP time period. In the Southeastern U.S., however, this pattern is not found; all four morphologies increase significantly over time. Contrastingly, California samples exhibit *decreasing* bi-iliac breadth over time, though stature and body mass both increased. Again, this regional variation belies the apparent patterns obtained when observing the total sample, and merits further investigation when environmental factors are also considered.

Sexual dimorphism – indices:

The means for the postcranial proportions, their standard deviations, and percentages of sexual dimorphism—calculated from the subset of the total sample with all of these proportions available—are presented in Table 6.7.1. Considered across the total available sample, a Student’s *t*-test indicates that three of the five postcranial proportions are significantly sexually dimorphic ($p < 0.01$): relative torso height, brachial index, and relative upper limb length/torso height. This pattern is consistent when only the subset of skeletons with all five indices available is considered, or when sample means (and not individual data) are compared. Males generally have higher values for these proportions, except relative torso height. This difference indicates that males have relatively longer limbs than females, but the ratio of upper to lower limb lengths remains consistent between males and females.

Percentages of sexual dimorphism and statistical significance among these indices, through time, are also presented in Table 6.7.1. Like the changes in sexual dimorphism through time for the cranial module and nasal index, there are notable temporal trends in relative torso height and the relative length of upper limb to torso height. Samples from the most recent aggregated time period (1500–100 yBP) show less sexual dimorphism in the length of the torso than the middle aggregated time period (4000–1500 yBP); this is an effect

Table 6.7.1. Sex means and standard deviations of postcranial proportions using only individuals in the POD with all postcranial derived dimensions available (336 males and 285 females). The majority of this sample comes from the most recent aggregated time period, and may be significantly affected by regional biases. Index values are percentages. Sexual dimorphism percentages (SD%) are calculated from the means presented. **Bold** text indicates significant sexual dimorphism based on Student's *t*-test results.

Time Period (yBP)	Relative torso height		Brachial index		Crural index		Relative upper limb length/torso height		Interlimb index		
	Mean	Standard Deviation	Mean	Standard Deviation	Mean	Standard Deviation	Mean	Standard Deviation	Mean	Standard Deviation	
♂	All	47.35	2.45	77.20	2.70	84.19	2.62	148.25	7.27	70.04	1.73
	1500-100	47.36	2.48	77.14	2.76	84.22	2.65	147.98	7.10	69.93	1.74
	4000-1500	47.74	2.28	77.39	2.67	83.71	2.73	147.96	7.56	70.49	1.64
	8000-4000	46.54	2.43	76.76	1.99	84.59	1.99	152.10	8.25	70.62	1.73
♀	All	48.19	2.47	76.14	2.91	83.86	2.51	144.83	7.50	69.64	1.65
	1500-100	48.09	2.41	76.14	2.94	83.90	2.47	144.96	7.23	69.55	1.63
	4000-1500	49.35	2.77	75.89	2.64	83.20	2.97	142.09	8.74	69.91	1.71
	8000-4000	47.74	1.82	75.81	2.51	84.38	1.85	148.07	5.35	70.61	1.16
Sexual dimorphism			SD%	SD%	SD%	SD%	SD%	SD%	SD%	SD%	SD%
	All	-1.76		1.38		0.39		2.33		0.57	
	1500-100	-1.53		1.30		0.38		2.06		0.54	
	4000-1500	-3.32		1.96		0.61		4.05		0.83	
8000-4000	-2.55		1.25		0.25		2.69		0.01		

of females with relatively taller torsos in the middle period. Interestingly, overall, the greatest overall sexual dimorphism is found during the 4000–1500 yBP sample. Yet, a dominant portion of the sample considered across all time periods is from the most recent time period (261 males, 228 females), representing the greatest geographic range, and thus biases the measures of sexual dimorphism and the overall mean for these proportions. A MANOVA reveals that regional bias is significantly affecting these results. These patterns for the total sample are likely accurate indicators of sexual dimorphism in these proportions for the total sample. However, the addition of more equal representation of regions and time periods may have a significant effect on the reported patterns of sexual dimorphism.

These results indicate that all proportions should be examined separately by sex. Crural index and interlimb index do not differ significantly between males and females, but the regional and temporal variation in their sexual dimorphism are likely obscured by total sample trends. In addition, the results of both the general temporal trend and the sexual dimorphism analyses indicate much variation in human postcranial proportions through time and across geography in the total sample.

Sexual dimorphism – morphology:

Table 6.7.2 reports the temporal means, standard deviations and percentages of sexual dimorphism for postcranial morphologies, including stature. Despite the effects of regional sample disparities in each time period, an examination of sexual dimorphism in body breadth, stature and mass is still merited to determine underlying patterns of variation that may exist in these morphologies. In the total sample, across all time periods, as well as in the subset of the sample with all of these dimensions available, all four morphologies are sexually dimorphic. In all four morphologies, males have greater dimensions, reflecting

Table 6.7.2. Sex means and standard deviations of postcranial morphologies using only individuals in the POD with all postcranial dimensions available (336 males and 285 females). The majority of this sample comes from the most recent aggregated time period, and may be significantly affected by regional biases. Sexual dimorphism percentages (SD%) are calculated from the means presented. **Bold** text indicates significant sexual dimorphism based on Student’s *t*-test results.

	Time period (yBP)	Upper body breadth (mm)		Stature (cm)		Body mass (kg)		Bi-iliac breadth (mm)	
		Mean	Standard Deviation	Mean	Standard Deviation	Mean	Standard Deviation	Mean	Standard Deviation
♂	All	329.1	20.16	162.7	7.03	66.80	6.64	271.4	15.31
	1500-100	330.1	19.52	162.7	6.83	67.19	6.76	272.5	15.25
	4000-1500	330.3	22.30	162.9	8.43	67.16	5.44	271.2	15.03
	8000-4000	315.2	21.46	161.5	6.43	60.85	6.02	257.2	10.99
♀	All	297.2	17.38	152.7	6.35	55.86	5.84	261.5	13.59
	1500-100	297.9	17.31	152.8	6.37	55.02	5.79	261.5	13.21
	4000-1500	298.8	17.14	152.3	6.13	57.79	4.84	268.0	12.59
	8000-4000	286.6	16.83	151.1	7.12	50.05	4.90	250.7	13.18
Sexual dimorphism		SD%		SD%		SD%		SD%	
	All	10.19		6.34		17.84		3.72	
	1500-100	10.25		6.28		19.92		4.12	
	4000-1500	10.01		6.73		15.00		1.19	
	8000-4000	9.50		6.65		19.48		2.56	

generally larger body size. Comparisons of aggregated time period sample means support consistency in male and female differences in these four dimensions.

A Student’s *t*-test shows that all four dimensions remain sexually dimorphic through time when individual data—both the total available sample and individuals with all postcranial dimensions available—are considered. Despite the problems cited when considering postcranial proportions, comparisons of the four postcranial dimensions using sample means yield identical results, with the exception of bi-iliac breadth between males and females in

the 8000–4000 yBP time period. As in the analysis of postcranial proportions, results from a MANOVA indicate that regional differences in these four postcranial morphologies are significant, and so degrees of sexual dimorphism may also vary regionally. However, the general accordance of results obtained from different subsets of the total sample (all available skeletons, individuals with all measurements available, and sample means) points to consistent sexual dimorphism in these four traits; males are, on average, significantly broader, taller, and more massive than females through time. Also, males have wider upper bodies relative to lower bodies compared with females.

Scaling and COVs for indices:

As noted, the temporal and sexual dimorphism trends in postcranial dimensions indicate a great amount of temporal and regional variation. However, the relative variation in the measurements that are used to determine these morphologies, and therefore driving their complex variation, should be investigated. Relative scaling among the component measurements has been described in previous studies (see Chapter 3) in relation to morphological changes in response to climate and subsistence factors.

Log-transformed component measurements of the five postcranial proportions for sex-specific samples are regressed using reduced major axis (RMA). The resulting equations for these are presented in Table 6.8, with standard errors of the estimate and Pearson's r -coefficients. All of the regressions yield significant results, and have correlation coefficients high enough to merit analyses of slope isometry. Using the modified t -test statistic described by Hofman (1988), three postcranial proportions are determined not to scale isometrically in both sexes ($p < 0.01$): brachial index, crural index, and interlimb index. Distal elements disproportionately lengthen in the intralimb indices; longer upper limbs have relatively

Table 6.8. RMA regression results of log-transformed component measurements for postcranial indices. All regressions are significant ($p < 0.01$). **Bold** regression equations indicate slopes that significantly depart from isometry after a Student's t -test (Hofman, 1988). Note that the "Y" components (i.e., dependent variables) are the numerators from the indices.

MALES	Relative torso height	Brachial index	Crural index	Relative upper limb length	Interlimb index
Y/X component measurements	$\Sigma (XT1-XL5)/ (FBL+TML)$	RML/HML	TML/FBL	$(HML+RML)/ \Sigma (XT1-XL5)$	HML+RML/ FBL+TML
<i>n</i>	678	1446	1456	680	1326
Regression equation	1.091x + 0.212	1.176x - 1.264	1.143x - 1.036	0.972x - 0.217	0.953x - 0.038
Standard error of the estimate	0.0441	0.0352	0.0258	0.0430	0.0246
Pearson's <i>r</i>	0.559	0.823	0.884	0.594	0.892
FEMALES					
<i>n</i>	558	1176	1189	566	1077
Regression equation	1.070x + 0.324	1.230x - 1.578	1.135x - 0.983	0.955x - 0.090	0.993x - 0.313
Standard error of the estimate	0.0448	0.0371	0.0257	0.0445	0.0257
Pearson's <i>r</i>	0.525	0.820	0.881	0.525	0.886

Table 6.9. RMA regressions of log-transformed individual limb elements against torso height (TH, thoracic + lumbar maximum anterior heights). All regressions are significant ($p < 0.01$). **Bold** regression equations indicate slopes that significantly depart from isometry after a Student's t -test (Hofman, 1988).

		HML/TH	RML/TH	FBL/TH	TML/TH
<i>n</i>		693	682	690	686
MALES	Regression equation	1.000x + 0.179	1.187x - 0.600	1.043x - 0.406	1.213x - 1.233
	Standard error of the estimate	0.0446	0.0430	0.0450	0.0446
	Pearson's <i>r</i>	0.548	0.595	0.537	0.546
<i>n</i>		581	574	569	569
FEMALES	Regression equation	1.008x + 0.142	1.243x - 0.856	1.000x - 0.130	1.146x - 0.810
	Standard error of the estimate	0.0454	0.0451	0.0458	0.0455
	Pearson's <i>r</i>	0.494	0.500	0.493	0.497

Table 6.10. Coefficients of variation (CV) for postcranial measurements (male $n = 682$; female $n = 569$). See Appendix II for measurement definitions (TH, thoracic and lumbar vertebrae combined heights; ULL and LLL, upper and lower limb lengths, respectively). Asterisks indicate significantly higher variance than associated measurement(s) used in calculating morphologies, as determined by an ANOVA.

	Postcranial dimension						
	HML	RML	FBL	TML	TH	ULL	LLL
Males	5.33	6.15*	5.48	6.25*	5.29	5.55	5.67
Females	5.33	6.44*	5.43	6.11*	5.24	5.52	5.65

longer radii, and longer lower limbs have relatively longer tibiae. In the interlimb index, the upper limb is slightly negatively scaled relative to the lower limb among males only.

Interestingly, both limbs scale isometrically with torso height.

Even though total limb lengths change in concert with torso height, these results imply that limb segments do not contribute to these total limb lengths equally as limbs lengthen. An examination of limb segment lengths relative to torso height (Table 6.9) confirms this. Humerus maximum length and femoral bicondylar length scale isometrically with torso height, while the distal limb segments both scale positively relative to torso height.

These results are further supported by the coefficients of variation for these dimensions (Table 6.10). Both radius and tibia maximum lengths have significantly greater variation than the length of their respective proximal elements. This is determined by comparing radial length and tibial length to humeral length and femoral length, respectively, in one-way ANOVAs. Variation among the total limb lengths and torso height, though, do not significantly differ. The covariances of these dimensions—especially those within limbs—is higher than those found among the cranial dimensions, as implied by the correlation coefficients of the regressions. This is despite the considerable differences in variation and scaling.

6.2.3: Cranial and postcranial variation in relation to each other (Mantel tests)

After considering the patterns of variation among morphologies within the crania and within the postcrania, it is useful to examine how they relate to each other. The covariance of cranial morphologies with each other, of postcranial morphologies with each other, and between cranial and postcranial morphologies has not been clearly demonstrated in the preceding analyses, though some of the relationships of component dimensions from indices were described. Two methods may be employed to investigate these: bivariate correlations, and Mantel tests based on models designed using the results of previous studies.

Bivariate correlations were run on a subset of the morphologies considered in the previous subsection: cranial index, cranial module, facial index, nasal index, brachial index, crural index, relative torso height, and bi-iliac breadth. These were chosen to minimize collinearity among the proportions considered and to maximize the available sample. Pearson's r -coefficients for males and for females are reported in Table 6.11 and Table 6.12, respectively. Significant correlations, after a Bonferroni correction, are bolded. Note that both males and females have similar correlations among cranial proportions and among postcranial proportions (Tables 6.11.1 and 6.12.1), though there are some differences in the correlations between cranial and postcranial proportions (Tables 6.11.2 and 6.12.2).

No cranial morphologies are significantly correlated with each other, with the exception of facial and nasal indices among females, and are all very low in both sexes. Cranial module, which is related closely to cranial volume (Beals et al., 1983), has no relationship with nasal or facial indices, and a very low negative correlation with cranial index. These indicate a lack of correspondence between neurocranial volume and cranial proportions. Furthermore, the cranial, facial, and nasal indices have low, positive correlations ($r < 0.25$)

Table 6.11.1. Correlations of cranial and body proportions for males ($n = 322$), cranial and body proportions considered separately. Cranial correlations are on the upper right; body proportions are on the lower left. **Bolded** correlations are significant after a Bonferroni correction ($p < 0.05$).

		Cranial module	Nasal index	Facial index	
		-0.109	0.108	0.125	Cranial index
Cranial index	0.581		0.011	0.085	Cranial module
Relative torso height	0.050	-0.166		0.136	Nasal index
Bi-iliac breadth	-0.024	0.007	-0.092		
	Brachial index	Cranial index	Relative torso height		

Table 6.11.2. Correlations between cranial and body proportions among males

	Cranial index	Cranial module	Nasal index	Facial index
Brachial index	0.067	-0.078	0.359	0.067
Cranial index	0.012	-0.096	0.212	0.047
Relative torso height	0.171	-0.122	0.099	0.065
Bi-iliac breadth	-0.073	0.234	-0.094	-0.093

Table 6.12.1. Correlations of cranial and body proportions for females ($n = 271$), cranial and body proportions considered separately. Cranial correlations are on the upper right; body proportions are on the lower left. **Bolded** correlations are significant after a Bonferroni correction ($p < 0.05$).

		Cranial module	Nasal index	Facial index	
		-0.131	0.089	0.095	Cranial index
Crural index	0.572		0.022	0.114	Cranial module
Relative torso height	-0.067	-0.064		0.219	Nasal index
Bi-iliac breadth	-0.011	-0.015	0.020		
	Brachial index	Crural index	Relative torso height		

Table 6.12.2. Correlations between cranial and body proportions among females

	Cranial index	Cranial module	Nasal index	Facial index
Brachial index	0.209	-0.152	0.127	0.033
Crural index	0.128	-0.152	0.054	0.127
Relative torso height	0.150	-0.055	0.087	-0.080
Bi-iliac breadth	-0.030	0.333	-0.118	0.001

among each other. Only in females do nasal and facial indices significantly correspond, but this is marginal. As shown in the analyses in section 6.2.1, these two dimensions do change similarly through time, reflecting this slight correspondence. These correlation results also indicate some correspondence among these proportions in relative increases in breadth measurements; there is a weak trend in which individuals with relatively wider neurocrania have broader faces and nasal apertures.

The patterns among postcranial proportions contrast somewhat with those of cranial proportions, though they generally also show the same, low correspondence. Intralimb indices have significant ($p < 0.01$) moderately high correlations ($r > 0.5$) in both sexes; individuals with relatively longer (lower) legs have relatively longer forearms. A low correlation exists among males in relative torso height and crural index, though this may be slightly inflated by having two dimensions in common—femoral bicondylar length (FBL) and tibial maximum length (TML). A partial correlation controlling for both reduces the correlation for males to 0.057. Therefore, with the exception of intralimb indices, there is little correspondence among postcranial proportions.

Between cranial and postcranial proportions, males and females generally present similar correlation patterns, though there are notable differences. Namely, females show a significant, albeit low correlation between cranial index and brachial index, whereas no relationship is apparent between these two morphologies in males. Males, contrastingly, exhibit moderate, significant correlations ($p < 0.01$) between nasal proportions and intralimb indices, which, while also positive among females, are lower and fail to reach significance. Cranial module and bi-iliac breadth have moderately high, significant correlations in both sexes; both are related to body size, so this correspondence is not surprising. A noteworthy

group of correlations are those between cranial module and postcranial proportions: individuals with larger crania have lower intralimb indices. On the whole for both sexes, however, there are very low, non-significant correlations between cranial proportions and postcranial proportions. However, these results also suggest that individuals with low intralimb indices have narrower nasal apertures.

The results of previous studies are employed in the design of hypothetical variance-covariance (V/CV) models to test against the observed V/CV matrices of cranial and postcranial proportions of males and females, both for the total sample using sample means and within individual samples, using Mantel tests. A variance-covariance matrix was determined, by sex, for most of the dimensions considered above in the bivariate correlations. As cranial module and bi-iliac breadth have low correlations with all proportions (except each other), and as they are measurements of size rather than proportion, they have been left out of this analysis. Four hypothetical V/CV matrices were then devised based on expected relationships among these dimensions based on previously-reported patterns of variation among them (e.g., Newmann, 1953; Roberts, 1978). These hypothetical matrices are constructed with two states: zero, indicating independent variance between the proportions considered; and one, indicating covariance between the proportions considered. In these models the following dimensions are hypothesized to covary, and are given scores of “1”:

Model 1: all cranial proportions with each other; nasal index with intralimb indices; brachial with crural indices

Model 2: facial with nasal indices; brachial with crural indices

Model 3: all cranial proportions with each other; all postcranial proportions with each other

Model 4: all cranial proportions with each other; brachial with crural indices

Total sample results:

The results for the Mantel test between the hypothetical models and the V/CV matrix of proportions for sample means of all of the males and all of the females from the total sample are presented in Table 6.13. Correlations between models and actual V/CV matrices that are greater than $r = 0.10$ are indicated. The pattern of covariance for males is best predicted by Model 2 ($r = 0.739$), which is similar to the results obtained in the bivariate correlations. However, covariance among the females' proportions is different from those found among males and the results of the correlation analyses that are reported in Table 6.12. It is noteworthy that Model 1 provides the next closest correlation coefficient to the male results ($r = 0.732$), and Model 2 the second best correlation coefficient to the female results ($r = 0.662$). The general results of this analysis indicate that, for both males and females in the total sample, cranial proportions generally correspond in their patterns of variation, as do intralimb proportions with each other. Other postcranial proportions, however, do not generally covary.

Within-sample analyses:

Previous studies suggest that the proportions under study here respond at different rates to environmental factors. A null hypothesis of this study would be that patterns of correspondence (e.g., high correlation coefficients in the Mantel test results) among proportions in the total sample would be expected if those proportions were morphologically integrated. This would, therefore, either argue for highly similar sensitivity to climatic and other environmental stress in those proportions, or for the overriding influence of intrinsic factors on those morphological elements. Mantel tests were conducted on skeletons from the

Table 6.13. Best correspondence of V/CV matrices with models of the relationships of cranial and postcranial proportions, based on Mantel tests. See text for explanations of the models. An upper-case “X” designates models that correlate with an r higher than 0.5, a lower case “x” correlations with an r higher than 0.3, and a period (“.”) a correlation higher than 0.1. The **bold** symbol indicates the best corresponding model.

Sample examined (n)	Model				Pearson's r of best corresponding model
	1	2	3	4	
All males (322)	X	X		X	0.739*
All females (271)	X	X		X	0.725*
Ikowagamiut					
Males (17)	x				0.396
Females (21)	x	x	.	x	0.447
Tigara					
Males (11)		.		.	0.163
Females (14)		<i>None</i>			
Ryan Mound					
Males (20)	X	X	x	X	0.627
Females (20)	X	X	x	X	0.536
Windover					
Males (6)	x	X	X	X	0.691
Females (4)			x		0.307
Dickson					
Males (10)		<i>None</i>			
Females (8)	x		.		0.378
Indian Knoll					
Males (16)		<i>None</i>			
Females (17)	x	X	.	X	0.538
Hawikuh					
Males (7)	x	X	x	X	0.634
Females (7)	.	X	x	X	0.637
Mobridge					
Males (13)	X				0.648
Females (10)		<i>None</i>			
Sadlermiut					
Males (22)	.	.	x	.	0.301
Females (13)	x	X	x	X	0.643

* Correlation is significant ($p < 0.05$).

nine sites listed in Table 6.13. The models correlating with the highest Pearson's coefficients to the V/CV matrix of each sex within these samples are designated in bold text, and their correlation values are noted.

Although in many instances the models perform well within samples (i.e., $r > 0.5$), none reach statistical significance. Moreover, the hypothetical V/CV models corresponding to the total sample analysis only match the pattern among the pre-Yokut skeletons buried at Ryan Mound at the southern edge of the San Francisco Bay. No other samples match the V/CV patterns observed in the total sample, except females at Dickson, though a number of groups have results indicating limited correspondence ($r > 0.3$) with Models 1 and 2. Given the similarity of these models, it is not surprising that the correspondence of actual V/CV matrices with both occur. It should be noted that Model 3—which predicts that cranial proportions covary and postcranial proportions covary, but independent variance between cranial and postcranial proportions—performs poorly for all samples. However, Models 2 and 4—which predict low correspondence between cranial and postcranial proportions—perform better with more samples than the first model. All of the V/CV hypothetical models that perform well in multiple samples have two factors in common: high correspondence between intralimb indices, and high correspondence between nasal and facial indices.

Interestingly, four samples are not well-modeled by any of the hypothesized models. Bivariate correlations for each of these samples indicate that, surprisingly, brachial and crural indices have low, non-significant correlations ($r < 0.3$, $p > 0.05$). Furthermore, each site varies considerably in the correlations among the cranial variables. It is possible that these results indicate biased sampling from these sites, or population substructure, resulting from multiple reproductive groups at these sites or other causes for within-population variation.

Future analyses, possibly comparing coefficients of variation among groups within regions, may shed further light on the reasons for the poor fit of these exceptional groups to the models.

Based on the results reported by site and sex in Table 6.13, the patterns of correspondence between cranial and postcranial proportions observed in the total sample of pre-contact North American humans are not found within all samples. Despite the apparent variation within some samples, it is not possible to discount the possibility that morphological integration among some of these proportions—namely, brachial and crural indices, and nasal and facial indices—is significantly contributing to the patterns observed in the total sample. Also, as observed in the analyses of bivariate correlations, males and females, both in the total sample and within samples, have considerably different patterns of correspondence among their body proportions. How these patterns relate to temporal and geographic variation, sexual dimorphism, and change in response to environmental factors, is explored in the remainder of this chapter.

6.3: Patterns of morphological variation in relation to climate and geography

If any general conclusion emerges from the analyses of the previous section, it is that morphology in the Americas has been variable, and that both geography and time have significant influence on the distribution of that variation. Additionally, though there is some covariation between dimensions, many of these morphologies fluctuate independently of each other. Based on the evidence reviewed in Chapter 3, morphological variation in relation to climatic factors most likely contributed to the patterns. This section explores the relationships of climatic factors—mean annual temperature (MAT), mean high temperature of the warmest month (MXT), mean low temperature of the coolest month (MNT), and mean

annual total precipitation (MTP)—with morphology, across geography and through time. As before, the early Holocene skeletons are excluded because of their isolated nature; they cannot be aggregated in analyses into a “sample,” as they are geographically and temporally dispersed, and therefore likely represent multiple populations.

General patterns:

A general pattern of variation in morphology in relation to geography and to climatic factors should be established before analyzing them on a more detailed level. Both geography and climate are compared, in turn, with each morphology by bivariate correlations; the resulting Pearson's r 's are reported in this subsection. These are calculated using sample means, as individual variation within groups, and while unquestionably interesting, they add “noise” to the examination of this analysis. In addition, problems related to unequal sample sizes available for each dimension (see Table 6.1) are minimized by looking at group means.

The correlation of morphologies with geography—latitude and scaled longitude—are presented, by sex, in Table 6.14. Previous studies (e.g., Harvati and Weaver, 2006) have suggested that the inclusion of high latitude groups causes an inflation of the relationship of morphology with climatic variables, as they are extreme examples of climatic adaptation. In these analyses, high latitude samples are defined as those located more than 50 degrees north latitude (e.g., from south of the Aleutian Islands northward). As climate and latitude are related, including the high latitude samples may likely affect these analyses for the same reasons. Therefore, the regressions are conducted both on the total sample and on the subarctic sample.

Results of the regressions show that only some of the morphologies significantly

Table 6.14. Regression results for geography and morphology across all temporal periods: all regions contrasted with subarctic (below 50°N latitude) regions, POD *sample means*. Significant correlations ($p \leq 0.01$) are in **bold**. LAT = latitude; LONG = scaled longitude.

Dimension	Males				Females			
	All		Subarctic		All		Subarctic	
	LAT	LONG	LAT	LONG	LAT	LONG	LAT	LONG
Cranial index	-0.448	-0.146	-0.337	0.035	-0.347	-0.106	-0.259	0.047
Cranial module	0.202	0.110	0.195	0.085	0.211	-0.019	0.291	0.006
Facial index	-0.239	-0.121	-0.072	-0.066	-0.216	-0.116	-0.108	-0.091
Nasal index	-0.456	-0.256	-0.300	-0.040	-0.378	-0.251	-0.252	-0.067
Upper body width	0.002	0.115	0.284	0.306	0.031	0.023	0.250	0.169
Brachial index	-0.391	-0.321	-0.095	-0.063	-0.493	-0.286	-0.235	-0.054
Crural index	-0.482	-0.230	-0.244	-0.087	-0.567	-0.243	-0.383	-0.099
Torso height	-0.268	0.013	0.131	0.279	-0.179	0.000	0.244	0.215
Lower limb length	0.048	0.168	0.251	0.281	-0.096	0.192	-0.017	0.275
Relative torso height	-0.064	-0.215	0.064	-0.096	0.025	-0.248	0.116	-0.148
Upper limb length / torso height	0.098	0.243	0.058	0.250	0.040	0.206	-0.011	0.182
Interlimb index	-0.024	-0.128	0.080	0.100	-0.114	-0.119	-0.125	0.163
Stature	-0.267	0.264	0.060	0.414	-0.080	0.274	0.160	0.360
Body mass	0.297	0.198	0.162	0.127	0.375	0.218	0.307	0.176
Bi-iliac breadth	0.088	0.107	0.050	0.072	0.156	-0.015	0.190	-0.051

correlate with geography (generally, in these cases, Pearson's r -coefficients are greater than about ± 0.30). Notably, cranial index, nasal index, intralimb indices, and body mass have significant, moderate correlations with latitude in the total sample, though these generally lose statistical significance when only the subarctic sample is considered. Interestingly, in the total sample, only stature as a moderate, positive correlation with longitude, a relationship that increases when subarctic samples are considered alone. Subarctic samples also exhibit wider torsos and longer lower limbs (a component of stature) in lower longitudes. A trend

for lower brachial and nasal indices toward the west is artificially biased by the presence of arctic samples. These correlations indicate that individuals located in lower longitudes (e.g., eastern North America) are generally taller than those groups living to the west. This is visible on maps in Appendix VI (A6.6.1 and A6.7.1). Some of this pattern is influenced by the short individuals living in the arctic, but their exclusion interestingly implies that samples from farther south (e.g., the U.S. Southwest) are shorter relative to their geographic locations. Interestingly, the intralimb indices—namely crural index—do not exhibit the same pattern as stature or lower limb length, despite evidence (Table 6.8) that distal limb elements scale positively in relation to proximal elements and have higher coefficients of variation. It may be concluded from these various pieces of evidence that the taller individuals living toward the east do not necessarily have higher crural indices even though the tibia increases in length faster than the femur as lower limb length increases. Intriguingly, the similar correlation of relative torso height with longitude in subarctic samples—which implies individuals with relatively taller torsos to the east—further supports this conclusion, as lower limb length has been shown to scale isometrically with torso height. Finally, attention should be paid to the lack of general geographic patterning in bi-iliac breadth, despite differences in stature and body mass relating to latitude and scaled longitude.

Geographic trends, however, are not indicative of the specific covariation of morphology with climate. Although climate and geography are generally interconnected, they are not altogether congruent. Pearson's r -coefficients for morphologies and the four climatic factors, then, are presented in Tables 6.15.1 and 6.15.2 for males and females, respectively. The correlations of morphology to climate show that the variability of morphology relates to climate more in the postcrania than in the crania, and that the patterns are not always the

same for males and for females. The highest correlations are between temperature and nasal index, intralimb indices, and body mass consistently for both sexes. Removing the arctic samples (again, because of the evidence for their extreme morphology) reduces many of the correlations (grey columns, Tables 6.15.1 and 6.15.2), and increases others. Notably, crural index remains significantly correlated with MXT, cranial module remains significantly correlated with MTP, and, in females, body mass also remains correlated with temperature variables. A number of morphologies appear to correlate with MTP in the subarctic, though this is likely spurious. The populations of the Pacific Northwest experience precipitation levels considerably higher than the rest of North America (Table 6.2.4). Removing them from the analysis noticeably lowers some of the correlations of morphology with MTP. Intralimb indices, however, persist in showing a negative correlation with MTP; higher intralimb indices may be associated with drier (as well as warmer) climates. Also, cranial module consistently positively correlates with MTP.

A general implication of these results is that, considering results from both the total and subarctic samples, multiple morphologies in both males and females are influenced by (or at least covary with) climate. Among males, samples in warmer climates exhibit rounder crania, relatively wider faces and nasal apertures, longer torsos and lower limbs (as well as higher statures), and decreased body mass. In addition, in both warmer and drier climates, male samples have a tendency toward higher intralimb indices, and in cooler and wetter climates, males have larger crania and relatively shorter lower limbs relative to upper limb length. These trends also are evident among female samples, though are less pronounced in all but brachial indices, and generally of lower correlations for cranial, nasal, and interlimb indices, as well as stature. It is noteworthy that, despite the variation in stature and its

Table 6.15.1. Male correlation results of climatic factors and morphology across all temporal periods: all regions contrasted with subarctic (below 55°N latitude) regions, POD *sample means*. Significant correlations ($p \leq 0.01$) are shown in **bold**.

Derived morphology	<i>n</i>	MXT ¹		MNT ¹		MAT ¹		MTP ¹	
		All	Subarctic	All	Subarctic	All	Subarctic	All	Subarctic
Cranial index	69	0.237	-0.016	0.361	0.153	0.357	0.118	0.170	0.074
Cranial module	89	-0.236	-0.246	0.033	0.130	-0.054	0.017	0.341	0.372
Facial index	87	0.215	0.012	0.257	0.130	0.317	0.143	-0.031	-0.111
Nasal index	86	0.368	0.106	0.463	0.161	0.486	0.243	0.051	-0.056
Upper body width	72	0.199	0.030	-0.046	-0.349	0.058	-0.299	0.056	-0.013
Brachial index	91	0.448	0.079	0.385	-0.068	0.477	0.003	-0.076	-0.288*
Crural index	91	0.630	0.423	0.301	-0.161	0.527	0.144	-0.237	-0.502
Torso height	70	0.411	0.046	0.304	-0.141	0.410	0.063	0.254	0.131
Lower limb length	91	0.328	0.209	0.007	-0.226	0.195	-0.018	0.057	-0.004
Relative torso height	68	-0.042	-0.288	0.205	0.069	0.067	0.182	0.201	0.161
Upper limb / torso height	68	0.063	0.205	-0.170	-0.146	-0.049	0.073	-0.073	-0.047
Interlimb index	89	-0.017	-0.217	0.171	0.014	0.084	-0.117	0.302	0.303*
Stature	65	0.411	0.160	0.246	-0.098	0.406	0.103	0.253	0.145
Body mass	91	-0.400	-0.261	-0.243	-0.011	-0.347	-0.151	0.070	0.158
Bi-iliac breadth	83	-0.225	-0.208	-0.045	0.050	-0.128	-0.076	0.082	0.110

* Not significant after excluding samples from the Pacific Northwest

¹ MAT, mean annual temperature; MXT, mean high temperature of the warmest month; MNT, mean low temperature of the coolest month; MTP, mean annual total precipitation

Table 6.15.2. Female correlation results of climatic factors and morphology across all temporal periods: all regions contrasted with subarctic (below 55°N latitude) regions, POD *sample means*. Significant correlations ($p \leq 0.01$) are shown in **bold**.

Derived morphology	N		MXT ¹		MNT ¹		MAT ¹		MTP ¹	
	All	Subarctic	All	Subarctic	All	Subarctic	All	Subarctic	All	Subarctic
Cranial index	74	67	0.165	-0.022	0.248	0.074	0.256	0.072	0.081	0.005
Cranial module	89	82	-0.084	-0.163	0.078	0.070	0.014	-0.041	0.323	0.322
Facial index	88	81	0.164	0.017	0.279	0.227	0.308	0.230	0.077	0.027
Nasal index	87	80	0.370	0.082	0.283	0.034	0.373	0.156	-0.043	-0.141
Upper body width	67	60	0.061	-0.113	0.125	-0.022	0.130	0.040	0.396	-0.357
Brachial index	91	84	0.488	0.131	0.416	-0.020	0.523	0.077	-0.119	-0.417*
Crural index	90	83	0.559	0.320	0.418	0.062	0.588	0.298	-0.181	-0.373*
Torso height	63	56	0.239	-0.193	0.322	-0.041	0.318	-0.129	0.439	0.364
Lower limb length	83	76	0.112	0.054	0.165	0.153	0.217	0.223	0.120	0.096
Relative torso height	65	58	-0.096	-0.298	0.171	0.094	0.003	-0.179	0.170	0.146
Upper limb / torso height	64	57	0.078	0.238	-0.187	-0.158	-0.027	0.101	-0.070	-0.049
Interlimb index	86	79	0.139	0.169	-0.011	-0.048	0.069	0.081	-0.134	-0.143
Stature	60	53	0.232	0.049	0.067	-0.150	0.188	-0.041	0.297	0.247
Body mass	91	84	-0.382	-0.305	-0.296	-0.143	-0.373	-0.284	0.104	0.174
Bi-iliac breadth	85	78	-0.088	-0.107	-0.053	-0.034	-0.071	-0.095	-0.069	-0.070

* Not significant after excluding samples from the Pacific Northwest

¹ MAT, mean annual temperature; MXT, mean high temperature of the warmest month; MNT, mean low temperature of the coolest month; MTP, mean annual total precipitation

components in relation to climate, relative torso height *does not* significantly (or even highly) covary with any climatic factor, even though it has a high, negative correlation with scaled longitude in subarctic samples.

Some of these results are suspect, however. They combine a diverse range of time periods, but are dominated by samples from the last millennium. MTP, for instance, is known to correlate significantly with MNT ($r = 0.275$, $p = 0.01$), and all of the temperature variables are related. Thus, the correlations reported may be slightly inflated. The exclusion of seven samples from only two regions (the arctic regions)—granted, including samples potentially exhibiting morphological extremes—drastically changes the relationship of climate with morphology. Were climate to consistently correlate with morphologies, this difference in overall sample composition should not change the results as extensively as is evident in Table 6.15, unless the remaining samples do not represent a diversity of climates. This is not the case with the subarctic sample here, which includes the arid, warm deserts of the U.S. Southwest, the cool temperate Northeastern Woodlands, and the subtropical samples from Florida and the Peruvian coast (see Table 6.2 and Appendix IV for a review of subarctic climatic diversity).

One hypothesis of this study is that, if populations immigrating to and within the Americas settled in different environments from those to which they had previously adapted, the relationship between climatic factors and morphology would be lower than in groups who had remained in the same environment over time. Furthermore, more groups would exhibit stronger relationships with climate in more recent time periods, as they would have lived in the Americas for a longer time period (assuming that movement among these groups was limited), therefore providing more time for morphology to potentially respond to

environmental factors. By combining temporal periods in this general analysis, were this hypothesis upheld, the relationship of climate and morphology would be decreased by mixing groups that had “adapted” to their local environmental climates with those that had not. As climatic factors change within regions over time as well, it may also be possible that no groups have lived in stable enough climates to allow for morphological change that consistently matches with climatic factors, depending on the amount of time necessary for morphologies to “adapt.”

Clearly, two courses of analysis must be taken to determine if these potential confounding factors are masking climatic relationships with morphology when they are examined across the entire POD. First, the relationship of morphology with climate within time periods is assessed, in order to test the hypothesis reiterated above. However, regional variation in climate and population composition (e.g., migration, or group sedentism versus replacement), as noted, are also potential confounding factors in both the total sample analysis and in analyses within temporal periods. Regional variations, across time periods when possible, will help elucidate this issue.

6.3.1: Variation within time periods across geography

Although all morphologies considered previously will continue to be analyzed in this section, special attention is paid to those factors that have been shown in the general analysis to significantly relate to geography and/or climate. Specifically, these are nasal index, intralimb indices, stature (and related factors), and body mass. Although cranial index, facial index and upper body breadth have some significant relationship with climate, their relationships are less consistent. Note that bi-iliac breadth has no apparent relation with climate or geography.

Quintiles for seven of these morphologies are plotted, by site, on maps of the Americas in Appendix VI: nasal index, brachial index, crural index, relative torso height, body mass, bi-iliac breadth, and stature. (Although relative torso height and bi-iliac breadth have no significant correlation with climatic factors in the overall analyses, they are included on these maps to further assess their variation, as they are hypothesized to vary clinally.) The quintiles (i.e., 0-20%, 21-40%, 41-60%, 61-80%, 81-100%) were calculated based on the total distribution of site means for these dimensions using the entire osteometric sample (POD, EOD, and COD), so that the variation of measurements in the Americas is contextualized within global variation. For example, bi-iliac breadths in the Americas, though diverse, do not include any that are as narrow as those found in sub-Saharan Africa (a sample from which is included in the COD). These maps, then, also readily demonstrate which traits are more or less variable in the New World. Note that these appendix maps are divided into the time periods designated in the Methods chapter, with the exception of an aggregated time period between 8000 and 4000 yBP. The 8000–6000 yBP and 6000–4000 yBP time periods are aggregated to bolster the sample size and geographic distribution considered among these oldest samples. The earliest Holocene skeletons are not considered in this section, and are not plotted on the temporally-divided maps. They are represented on the maps depicting all time periods, though they are coded using the same symbols and colors as the remaining samples. Readers are encouraged to reference these maps while reading through these results to help clarify the patterns described. Note that these Appendix VI figures provide Pearson's r correlation coefficients for comparisons between morphologies and temperature, as well as semi-partial correlations for comparisons with precipitation.

Analyses of the relationship of morphologies to climate are conducted in this section using bivariate correlations. Multivariate statistics would be preferable for these analyses, but were not successfully used. As noted at the beginning of this chapter, factor analyses cannot be employed, as the climatic variables do not reduce to a single factor. The temperature variables do reduce to a single factor, but precipitation is not contributory to that factor (possibly due to its considerably higher variance). Moreover, the climatic factors are collinear, and therefore cannot be examined using multivariate statistics or ANOVAs (even as a combined temperature factor and precipitation).

In order to assess the relative covariation of each climatic factor with morphology, bivariate correlations are the best remaining statistical option. Multiple regressions are an alternative option, but I have chosen not to use them. Statisticians argue that high correlations among the independent variables in a regression—and therefore high collinearity—invalidate the statistical assumptions of regressions and therefore make the obtained coefficients highly suspect (e.g., Bowerman and O’Connell, 1990). Multiple regressions could be employed to analyze the relationships of climatic variables with morphologies despite this collinearity (Berry, 1993), but the correlation coefficients are inflated and would be subject to statistical artifacts. However, when precipitation and climate—especially MNT—both exhibit significant covariance with a morphology, semi-partial correlations are used to determine if the result is spuriously caused by the generally significant correlation between these variables. These post-hoc semi-partial correlations are reported below in the results when appropriate (i.e., if any reported significant covariance with MTP is the result of a partial correlation), along with bivariate correlations for individual temperature variables with morphologies. The strengths of bivariate correlations

are affected by sample sizes, and so are better employed using individual data, instead of sample means. Analyses in this subsection and the subsequent subsection are carried out using individual data, though it is acknowledged that this may cause some difficulty in interpreting results due to the confounding factor of within-population variation. A large number of planned bivariate correlations are therefore conducted in these analyses, so an alpha value of $\alpha = 0.01$ is favored for identifying significant relationships in order to reduce the chance of making a Type I error, though all correlations with a $p \leq 0.05$ are reported.

Given the complexity of the examination in this subsection, the main results may easily be lost in the number of analyses. For this reason, climatic analyses within time period assess only morphologies that significantly vary among samples, with special attention placed on the morphologies graphed in Appendix VI. A summary of results and general trends follows the analyses by time period, and specific results are summarized for each time period on tables. These results are also reported on the individual maps for each morphology and time period in Appendix VI. Abbreviations are used for morphologies and for climatic factors in these tables, which are defined in the text and are summarized on page 585.

A final caveat concerning these results is that, though correlation coefficients are cited throughout the analysis, these are, of course, never meant to imply causation. It is not parsimonious, however, to suggest that humans coincidentally settled in places where the pattern of variation in their physiques would significantly covary with climate, especially as some morphologies covary with various climatic factors more readily than others, and in different combinations of factors. Furthermore, as climate and geography, noted above, are inexorably linked, no single climate or geographic variable is intended to be the sole factor associated with these morphologies. For simplicity, however, those with significant

relationships are the only ones presented. These topics will be considered further in the Discussion (Chapter 7).

8000-4000 yBP:

There are few samples available between circa 8000 and 6000 yBP: Eva (Tennessee), Tick Island (Florida), some of the La Jolla skeletons (Baja California), Crypt Cave (Nevada), and Windover Pond (Florida). These provide very little geographic range, and both Crypt Cave and Tick Island are very small, highly fragmentary samples. Moreover, Tick Island and the Eva site both extend temporally into the next time period (6000 to 4000 yBP), while Windover Pond's mean temporal age is around 8100 yBP. So, this time period has been combined with the 6000 to 4000 yBP period for analysis. This adds Indian Knoll (Kentucky) and Ellis Landing (California) to the total sample. As a caution, combining such a wide time frame may disguise more subtle effects occurring within each time period, though these cannot be determined in the 8000 to 6000 yBP time period alone due to sample constraints.

Morphological variation among groups in these time periods is similar between males and females. Refer to the sample means reported in Appendix V, Part B. Comparisons among samples with more than five skeletons (i.e., not Tick Island or Crypt Cave) were analyzed using one-way ANOVAs. Significant differences ($p < 0.05$) are found in cranial index, cranial module, brachial index, relative torso height (RTH), relative upper limb length/torso height (ULTH), interlimb index (ILI), bi-iliac breadth (BIB) and body mass (BM). There is a tendency for Californian samples to be wider-bodied and more massive, with larger crania and higher brachial indices, as well as relatively long torsos, compared to the three Southeastern U.S. samples (Eva, Indian Knoll, and Windover). Such distinctions are notable for bi-iliac breadth and body mass on Appendix VI figures (A6.5.2, A6.5.5,

Table 6.16. Significant correlations ($p < 0.05$) of morphologies among 8000-4000 yBP samples with climatic factors, after semi-partial correlation. Strictly significant relationships ($p < 0.01$) are in **bold**. Superscripts indicate a positive or negative correlation. When no climate variable significantly covaries with a morphology, it is designated as “none”.

Sex	Morphology									
	Cranial index	Cranial module	Nasal index	Crural index	RTH	ULTH	ILI	BIB	BM	Stature
♂	MAT⁺ MXT⁺ MNT⁺	MAT ⁻ MTP⁻	none	none	MNT⁺ MTP⁻	MNT ⁻ MTP⁺	MAT⁺	MAT⁻ MXT⁻ MTP⁻	MAT⁻ MXT⁻ MTP⁻	none
♀	none	MAT⁻	none	none	none	none	MAT⁺	MAT⁻ MXT⁻	MAT⁻ MXT⁻	MTP⁻

A6.6.2 and A6.6.5). Thus, a geographic distinction is made through this analysis.

Are these differences related to climate? A series of bivariate correlations reveal that climatic factors have a significant relationship with morphologies more often among males than among females. The climatic variables that significantly correlate are listed in Table 6.16 for the morphologies that significantly differ among samples, as well as those graphed in Appendix VI (except brachial index, which does not have any significant relationship with climatic variables). Among male samples, the individuals from warmer climates have rounder crania and a tendency toward longer upper limbs relative to lower limbs; additionally, in warmer and drier climates, male samples have relatively longer torsos. However, in colder and drier climates, the males from this time period tend to have higher body masses (also reflected in their cranial modules), and, in the same climates, both sexes trend toward wider pelves. Interestingly, females have a trend ($r = -0.319$) toward greater stature in drier climates. Also, intralimb indices do not covary with any climate factors, though crural indices significantly differ among samples and both sexes exhibit relatively longer upper limbs in warmer climates.

In such a small sample (which is also geographically limited), it is difficult to assert that climatic factors are the major influencers of the patterns of morphological variation observed. It may be that the variation in some of these morphologies is more related to population history than climatic factors, especially given that the range in climates among the samples considered is narrow. An indicator that this is a viable conclusion is the geographic as well as climatic patterning in the variation (though these are inexorably correlated), and the lack of significant covariance in most female morphologies with climatic factors, despite significant variation among them when comparing samples. Yet, some of the morphologies *do* correspond with climatic factors as would be anticipated from previous research, even in this ancient sampling; namely, note the correspondences with climate in male cranial module and body mass, in addition to bi-iliac breadth in both sexes.

4000-2500 yBP:

This time period is distinguished by including the oldest samples in the POD from the Pacific Northwest (Prince Rupert Harbor). There are, additionally, two skeletons (one of each sex) from Alaska (Norton culture skeletons from Point Hope). Also dating to this time period are the skeletons from San Nicholas Island (the southernmost Channel Island off the coast of California), as well as the eight skeletons from the Donaldson site in Ontario (though, unfortunately, this is one of the few sites for which a paleoclimate model could not be devised).

Morphological variation in this time period is somewhat different between males and females. One-way ANOVAs show significant differences among male proportions in crural index, interlimb index, and relative torso height, as well as both of its constituent parts—lower limb length (LLL) and absolute torso height (ATH). Significant size and shape

differences among males exist also in cranial module, stature, bi-iliac breadth, and body mass. Females have significant differences in interlimb index, stature, and body mass. They also have significant differences in lower limb length and in absolute torso height, though relative torso height does not reach strict significance ($F = 2.632, p = 0.02$). Similarly, bi-iliac breadth is not strictly significantly different among the females ($F = 2.242, p = 0.02$). The females do not exhibit significant differences in the other morphologies differing among males, but do have additional significant differences in cranial index and nasal index. Excluding the groups from the higher latitudes (the Norton culture skeletons and the skeletons from Prince Rupert Harbor)—as these have been shown in the previous subsection to skew morphological relationships with climate and geography, likely due to extreme body shape, size and proportions—most of the derived morphologies continue to significantly vary among samples from this time period. However, among males, crural index and relative torso height are not significantly different among lower latitude samples, and among females, interlimb index also ceases to significantly vary.

Climatic variables, however, have similar relationships with morphologies in both sexes, and are reported in Table 6.17 for all samples from this time period. Including the high latitude samples from Point Hope and Prince Rupert Harbor, male samples show limited covariance between climatic factors and morphologies: males in cooler (and drier) climates have *shorter* torsos (both absolutely and relatively), relatively longer upper limbs, wider bodies and higher body masses, and those in wetter climates have shorter lower limb lengths (absolute and relative to upper limb length). Females have nearly identical patterns, with two notable exceptions: females in warmer and drier climates have higher crural indices and shorter relative torso heights. Note that nasal and brachial indices, male crural index, and

Table 6.17. Significant ($p < 0.05$) correlations of morphologies among 4000-2500 yBP samples (including high latitude) with climatic factors. Strictly significant ($p < 0.01$) relationships are in **bold**. Superscripts indicate a positive or negative correlation. When no climate variable significantly covaries with a morphology, it is designated as “none”. Blank cells indicate morphologies not significantly varying among samples, and not covarying with any climate variables.

Sex	Morphology									
	Cranial module	Nasal index	Crural index	ATH	LLL	RTH	ILI	BIB	BM	Stature
♂	none		none	MXT ⁺	MTP ⁻	MAT ⁺ MXT ⁺	MAT⁺ MXT⁺ MTP ⁺	MXT ⁻ MTP⁻	MXT⁻ MTP⁻	none
♀	none	none	MAT⁺ MXT⁺ MTP ⁻	none	MTP ⁻	MAT⁻ MTP ⁺	MTP⁺	MAT ⁻ MXT ⁻	MAT⁻ MXT⁻ MTP ⁻	none

stature do not covary with any climatic factors.

Excluding the high latitude samples, there are many differences in the correlation of climatic factors with morphologies worth noting. MAT negatively covaries with cranial module and nasal index among subarctic males and females; humans in warmer climates have narrower crania and nasal apertures. Curiously, crural index ceases to correlate with any climatic factors among females, but subarctic males from this time period exhibit higher crural indices, shorter torso heights, narrower body breadths, and lower body masses in warmer and drier locations. Females exhibit the same trends in these latter three morphologies. These patterns match those previously reported for populations in warmer environments, and it is notable that subarctic males follow the expected pattern for relative torso height (i.e., longer lower limbs in warmer environments), while including the males from Prince Rupert Harbor result in a reversal of this pattern. Subarctic males and female samples also are taller in wetter and warmer climates.

An examination of the geographic patterns of these morphologies in the Appendix VI maps adds further information to these results. For example, subarctic males exhibit more of a clinal pattern in crural indices (Figure A6.3.2) when compared with females (Figure A6.3.5), reflecting the lack of covariance between crural index and climatic factors among subarctic females. The negative relationship between relative torso height and climate is corroborated by examining the relevant appendix maps as well (A6.4.2 and A6.4.5), demonstrating relatively longer torsos in more northern California and British Columbia. A comparison of Figures A6.5.2 and A6.5.5 shows that, despite the apparent covariance between the bi-iliac breadths of female samples with temperature, it is apparent that females tend to be generally wide-bodied in all locations except the Tennessee River Valley, whereas all males in lower latitudes tend to have narrower bodies (with the exception of the Sacramento Valley and San Francisco Bay samples). Although these are subtle differences (and demonstrate geographic patterns more than climatic ones), they may indicate differences between the sexes arising from mate choice or dissimilar degrees of sensitivity to climate in these morphologies between the sexes.

2500-1500 yBP:

By this time period, many of the regions of the POD are represented by at least one sample (see Appendix V – Part B). Twenty-one sites, most of which are aggregated into fifteen samples (the exceptional site being the single mummy from Fishbone Cave, Nevada), cover a geographic range from the Aleutian Islands and Point Hope to the Nasca Desert, and from the California coast (Point Sal) to the western coast of Florida (Bayshore Mounds and the Palmer site). Incipient horticulturalists are found in California and Illinois, and subsistence agriculturalists also appear during this period in South America, before

expanding into North America during subsequent periods. Questions concerning the effect of subsistence change on morphology will be addressed in the next section.

With this great geographic range, significant differences among samples occur in most derived morphologies. In both males and females, a one-way ANOVA demonstrates significant differences in cranial index, cranial module, nasal index, intralimb indices, absolute torso height, lower limb length, and stature. Incongruently, males significantly differ additionally in upper body width (UBW), interlimb index, and body mass, while females differ additionally in relative torso height and relative upper limb length/torso height. It is curious that, despite differences in its component dimensions, males do not significantly differ in relative torso height. Neither sex has significant differences among samples in facial index or bi-iliac breadth. Excluding the Western Arctic and Pacific Northwest samples, in both males and females, cranial index, cranial module, nasal index, brachial index, and lower limb length remain significantly different ($p < 0.01$); additionally, body mass remains significantly different among males ($p = 0.01$).

Considering high latitude and subarctic samples together, climatic factors have numerous significant relationships with morphologies among both males and females (Table 6.18). In cranial morphologies, both sexes exhibit higher cranial and nasal indices in warmer climates, as well as larger cranial modules in wetter environments. Interestingly, among females but not males, higher brachial indices positively correlate with temperatures, but both sexes are indicated as having higher cranial indices in warmer (and drier, in the case of males) climates. Both males and females also show positive covariation between temperature and absolute torso height and lower limb length. Females have a negative relationship between relative torso height and highest mean temperature of the warmest month ($r = -0.504, p < 0.01$), a

Table 6.18. Significant ($p < 0.05$) correlations of morphologies among 2500-1500 yBP samples with climatic factors, all regions and subarctic samples considered alone. Strictly significant ($p < 0.01$) relationships are indicated in **bold**. Superscripts indicate a positive or negative correlation. When no climate variable significantly covaries with a morphology, it is designated as “none”. Blank cells indicate morphologies not significantly varying among samples, and not covarying with any climate variables.

ALL REGIONS

Sex	Morphology													
	Cranial index	Cranial module	Nasal index	UBW	Brachial index	Crural index	ATH	LLL	RTH	ULTH	ILI	BIB	BM	Stature
♂	MAT ⁺ MXI ⁺ MNT ⁺	MTP⁺	MAT ⁺ MNT ⁺	MNT ⁺ MTP⁺	none	MAT ⁺ MXI ⁺ MNT ⁺ MTP ⁻	MAT ⁺ MXI ⁺ MTP ⁺	MAT ⁺ MXI ⁺			MAT ⁻ MXI ⁻	MAT ⁻ MXI ⁻	MAT ⁻ MTP⁺	MAT ⁺ MXI ⁺ MNT ⁺
♀	MAT ⁺ MNT ⁺	MTP ⁺	MAT ⁺ MXI ⁺ MNT ⁺		MAT ⁺ MXI ⁺ MNT ⁺	MAT ⁺ MXI ⁺ MNT ⁺	MXT ⁺	MAT ⁺ MXI ⁺	MXT ⁻	MXT⁺				MAT ⁺ MXT⁺

SUBARCTIC SAMPLES ONLY

Sex	Morphology													
	Cranial index	Cranial module	Nasal index	UBW	Brachial index	Crural index	ATH	LLL	RTH	ULTH	ILI	BIB	BM	Stature
♂	MAT ⁺ MXI ⁺ MNT ⁺	MTP ⁺	MAT ⁺ MNT ⁺ MTP ⁻		MAT ⁻	MTP ⁻	MAT ⁻ MNT ⁻	MAT ⁻ MNT ⁻ MTP ⁺				MAT ⁻ MNT ⁻	none	
♀	MAT ⁺ MNT ⁺	MTP⁺	MAT ⁺ MTP ⁻		MTP ⁻	MTP ⁻	MAT ⁻ MNT ⁻	MAT ⁻ MNT ⁻ MTP ⁺						MAT ⁻ MNT⁻

trend also indicated by the positive association of relative upper limb length/torso height (ULTH) with MXT. Although the absolute heights of female torsos are larger in warmer environments, the relative height is exceeded by the lengths of the limbs (as expected). Among males, the lengths of the limbs increase disproportionately in warmer climates as well, with lower limb lengths relatively longer in higher temperatures. Finally, both male and female samples are taller in climates with higher mean temperatures, and males have a tendency toward narrower bodies (despite not significantly differing among samples). Males also have wider upper bodies in warmer and wetter climates.

These results are changed when samples from the subarctic (excluding Western Arctic and Pacific Northwest regional samples) are analyzed alone. Cranial patterns are not changed, though note that among subarctic samples nasal index decreases in both cooler and wetter climates. Crural index continues to negatively relate to precipitation, though the index is not significantly difference among samples. Contrastingly, males have a *negative* relationship between brachial index and MAT, while female brachial indices are higher in drier environments. Consulting the Appendix VI figure (A6.2.3), it appears that low (<40th percentile) brachial indices in Southern Texas, Florida and California may be causing this reversal of trends reported when including the high latitude samples. The reversal of temperature and morphology relationships for absolute torso height, lower limb length, and, among females, stature are likewise the result of different trends between North and South America. In the subarctic sample, shorter statures among the Peruvian and Ecuadorian samples appears to be reversing the relationship observed when including high latitudes. This trend is also present among subarctic samples from the previous time period. Note that, despite these reversals, male bi-iliac breadths remain narrower in warmer climates, though no

significant difference among female groups exist. Again, these results show similarities between the sexes on some morphologies (namely intralimb indices and nasal index), but on others—namely stature and bi-iliac breadth—there are evident differences between males and females.

1500-1000 yBP:

This time period contrasts with the other temporal divisions of the latter Holocene, in that there are no arctic or subarctic samples in it. However, a great latitudinal geographic range is still covered: samples are from sites located from the northern Great Plains (the Snowflake site on the Sourisford River in Manitoba) to Ancón, Peru, including the only Mesoamerican sample considered in this study. (Without climate data, however, analyses will not include the sample from Péten, Guatemala.⁴) Therefore, analyses from this time period, like those of the 8000–4000 yBP temporal period, are conducted without need to exclude any samples due to known biases.

Morphological variation among the samples from this period is also unique compared with previous time periods, in that there is more significant variation among females than males. Among the males, cranial index, cranial module, nasal index, upper body width, lower limb length, relative torso height, upper limb length/torso height, and stature significantly vary among samples. Three of these are inherently related—lower limb length, relative torso height, and stature—and so likely stem from variation in one morphology, lower limb length. Females also differ significantly in these morphologies, as well as absolute torso height, crural index, and interlimb index.

⁴ The Altar de Sacrificios, a Mayan site, is located in a data gap in regard to climate data. No global climatological network stations were active there prior to 1987, and palynology data are currently very limited for this region, despite a wealth of research into the “collapse” of the Mayan Classic Period culture and its relationship with environmental factors.

Table 6.19. Significant ($p < 0.05$) correlations of morphologies among 1500-1000 yBP samples with climatic factors, all regions and subarctic samples considered alone. Strictly significant ($p < 0.01$) relationships are indicated in **bold**. Superscripts indicate a positive or negative correlation. When no climate variable significantly covaries with a morphology, it is designated as “none”. Blank cells indicate morphologies not significantly varying among samples, and not covarying with any climate variables.

Sex	Morphology													
	Cranial index	Cranial module	Nasal index	UBW	Brachial index	Crural index	ATH	LLL	RTH	ULTH	ILJ	BIB	BM	Stature
♂	MAT ⁻ MXT ⁻	MAT ⁻ MNT ⁻ MTP ⁺	MAT ⁻ MNT ⁻ MTP ⁺	MAT ⁻ MNT ⁻ MTP ⁺		MAT ⁺ MXT ⁺		MAT ⁻ MNT ⁻ MTP ⁺	MNT ⁺ MTP ⁻	MAT ⁻ MNT ⁻ MTP ⁺	MNT ⁻			MNT ⁻ MTP ⁺
♀	MAT ⁻ MXT ⁻	MAT ⁻ MNT ⁻ MTP ⁺	MAT ⁻ MNT ⁻	MTP ⁺	MXT ⁺	MAT ⁺ MXT ⁺	MAT ⁻ MNT ⁻	MAT ⁻ MNT ⁻ MTP ⁺	MNT ⁺ MTP ⁻	MNT ⁻ MTP ⁺	MNT ⁻			MAT ⁻ MNT ⁻ MTP ⁺

Bivariate correlations, presented in Table 6.19, indicate nearly identical relationships between climate and those morphologies varying within both sexes. In general, both males and females from warmer and drier locations have smaller crania, wider upper bodies, shorter lower and upper limbs (both absolutely and relative to torso height), and shorter statures. Additionally, samples from warmer environments demonstrate relatively narrower crania and nasal apertures, higher crural indices (and brachial indices, in the case of females), shorter torsos (again, only in females), and relatively shorter upper limbs relative to lower limbs. With the exception of cranial morphologies, these corroborate the results for the subarctic samples from the 4000–2500 yBP and 2500–1500 yBP time periods. The lack of climatic covariation or sample differences among bi-iliac breadths or body masses, despite sample differences and climatic factor covariation with stature, are notable.

It is possible, as this time period comprises samples that are transitioning to village horticulture and agriculture, that subsistence is an underlying factor in the observed variation; this is examined below in section 6.4.1. This prospect is preliminarily supported by the lower statures observed in the Mesoamerican and South American samples. Arguably, lower limb length is the common dimension influencing the negative relationship of climate with other morphologies. Crural index fails to significantly vary in relation to geography for either sex, but stature and absolute lower limb length do correlate with latitude in males and both latitude and scaled longitude among females (e.g., male stature and latitude, $r = 0.408$; $p < 0.01$; female lower limb length and latitude, $r = 0.559$; $p < 0.01$).

1000-500 yBP:

In this time period is the greatest concentration of samples. Forty-five samples, representing sixty sites from the POD and EOD, comprise this temporal division's total

sample.⁵ As made evident by Appendix VI maps A6.6.2 and A6.6.5 (which show the greatest extent of this sample), this time period also represents the greatest geographic range of any sample, extending from northern Gran Chaco/Patagonia to Chesterfield Inlet (along western Hudson Bay) and to Point Barrow, Alaska. Longitudinally, the sample includes the Neo-Aleut, numerous sites from California, almost the entire U.S. Southwest sample, and sites as far east as Irene Mound and the coast of Maine. Although not under consideration in this subsection, it should also be noted that five of the six subsistence strategies are present in this sample as well (there are no BSHG samples). Samples from the arctic and from the high-precipitation Northwest are also present in this sample, and so analyses are conducted with and without these high latitude samples included.

This time period also accounts for the most morphological variation observed so far among the temporal divisions. A one-way ANOVA shows that all of the morphologies significantly vary among groups except upper limb length/torso height among females. Among males, excluding the high latitude samples, facial index and interlimb index are not significantly different. Females, however, continue to have significant differences in interlimb index in the lower latitude samples, though they also cease to significantly differ in facial index, as well as in relative torso height.

Table 6.20 summarizes the results of bivariate correlations between all of these morphologies and temperature factors, as well as the results of semi-partial correlations of the morphologies with precipitation, controlling for temperature. Males and females have generally identical patterns: individuals in warmer, wetter climates exhibit higher cranial

⁵ There is a problem in this time period's sample not necessarily present in previous periods: sample size. While the previous temporal periods have had relatively limited samples (<200 in most cases), this time period has a relatively enormous total sample—up to 995 skeletons (538 males, 457 females). Because of this large a sample, there is a greater probability for Type I errors in analyses. The strict alpha-level for significance, however, will be maintained at 0.01, with this potential for spurious correlations to occur acknowledged.

Table 6.20. Significant ($p < 0.05$) correlations of morphologies among 1000-500 yBP samples with climatic factors, all regions and subarctic samples considered alone. Strictly significant ($p < 0.01$) relationships are indicated in **bold**. Superscripts indicate a positive or negative correlation. When no climate variable significantly covaries with a morphology, it is designated as “none”. Blank cells indicate morphologies not significantly varying among samples, and not covarying with any climate variables.

ALL REGIONS

		Morphology ¹														
		CRI	CRM	FI	NI	UBW	BI	CI	ATH	LLL	RTH	ULTH	ILI	BIB	BM	ST
♂	MAT ⁺	MAT ⁺	MAT ⁺	MAT ⁺	MAT ⁺	MAT ⁺	MAT ⁺	MAT ⁺	MAT ⁺	MAT ⁺	MAT ⁺	none	MAT ⁺	MAT ⁻	MAT ⁻	MAT ⁺
	MXI ⁺	MXI ⁺	MXI ⁺	MXI ⁺	MXI ⁺	MXI ⁺	MXI ⁺	MXI ⁺	MXI ⁺	MXI ⁺	MNT⁺	none	MNT ⁺	MNT ⁻	MXI ⁻	MXI ⁺
	MNT ⁺	MNT ⁺	MNT ⁺	MNT ⁺	MNT ⁺	MNT ⁺	MNT ⁺	MNT ⁺	MNT ⁺	MNT ⁺	MTP⁺	none	MTP ⁺	MTP⁺	MNT ⁻	MNT ⁺
	MTP ⁺	MTP⁺	MTP⁺	MTP⁺	MTP⁺	MTP⁺	MTP⁺	MTP⁺	MTP⁺	MTP⁺	MTP⁺	none	MTP ⁺	MTP⁺	MTP⁺	MTP⁺
♀	MAT ⁺	MAT ⁺	MAT ⁺	MAT ⁺	MAT ⁺	MAT ⁺	MAT ⁺	MAT ⁺	MAT ⁺	MAT ⁺	MAT ⁺	none	MAT ⁺	MAT ⁻	MAT ⁻	MAT ⁺
	MXI ⁺	MXI ⁺	MXI ⁺	MXI ⁺	MXI ⁺	MXI ⁺	MXI ⁺	MXI ⁺	MXI ⁺	MXI ⁺	MNT ⁺	none	MXI ⁺	MXI ⁻	MXI ⁻	MXI ⁺
	MNT ⁺	MNT ⁺	MNT ⁺	MNT ⁺	MNT ⁺	MNT ⁺	MNT ⁺	MNT ⁺	MNT ⁺	MNT ⁺	MNT ⁺	none	MNT ⁺	MNT ⁻	MNT ⁻	MNT ⁺
	MTP ⁺	MTP⁺	MTP⁺	MTP⁺	MTP⁺	MTP⁺	MTP⁺	MTP⁺	MTP⁺	MTP⁺	MTP⁺	none	MTP ⁺	MTP⁺	MTP⁺	MTP⁺

SUBARCTIC

		Morphology ¹														
		CRI	CRM	FI	NI	UBW	BI	CI	ATH	LLL	RTH	ULTH	ILI	BIB	BM	ST
♂	none	MXI ⁻	MTP⁺	none	MXI ⁻	MTP⁺	none	MXI ⁺	MAT ⁻	MAT ⁻	none	none	none	MAT ⁻	MXI ⁻	MXI ⁻
		MTP⁺			MTP⁺			MTP⁻	MTP⁺	MTP⁺	none	none	none	MTP⁺	MTP⁺	MTP⁺
♀	none	MTP⁺	none	none	none	MTP⁺	MAT ⁻	none	MXI ⁻	MTP⁺	none	none	none	none	MXI ⁻	MTP⁺
							MNT ⁻		MTP⁺						MTP⁺	

¹ CRI, cranial index; CRM, cranial module; FI, facial index; NI, nasal index; UBW, upper body width; BI, brachial index, CI, crural index; ATH, absolute torso height; LLL, lower limb length; RTH, relative torso height; ULTH, upper limb/torso; ILI, interlimb index; BIB, bi-iliac breadth; BM, body mass; ST, stature

indices, longer torsos and lower limbs, and taller statures. In warmer environments, as well, individuals exhibit relatively broader faces and nasal apertures, and higher intralimb indices (in addition, for males, higher crural indices in drier climates). Both males and females in wetter and colder places have higher body masses. Locations with milder winters are characterized by both males and females with relatively taller torsos, and drier climates with narrower upper bodies and smaller crania. An interesting difference between males and females, however, is the significant covariance of bi-iliac breadth with climate (narrower bodies in warmer and drier locations) among males, but not females, as well as covariance in cranial module for males with temperature.

Much of the covariation between morphology and climate disappears when high latitude samples are excluded. It is clearly evident that the extreme morphologies and climates of samples from the arctic and from the Pacific Northwest are largely responsible for the patterns observed in the entire sample from 1000–500 yBP. A trend persists for more massive individuals in locations with colder summers and wetter environments, but shorter males (attributable to shorter torsos and lower limbs) are also found in these environments. All cranial indices cease to covary with climate, as well as relative torso morphologies. It is noteworthy that among males, crural indices are negatively correlated with precipitation and positively with warmer summers, but not for females. However, females exhibit higher brachial indices in locations with *colder* climates, especially winters. These correlations, however, are low (MNT, $r = -0.143$; MAT, $r = -0.161$) and not strictly significant ($p > 0.01$), and so may not be biologically significant. Importantly, bi-iliac breadth again does not covary with climate among females (despite significant differences among samples), though it is greater among male samples in colder and wetter climates. Upper body breadth,

however, remains significantly correlated with precipitation for both sexes, though this arguably may be an effect of body size; subarctic female correlations between upper body breadth and body mass are significant ($r = 0.563$, $p < 0.01$). The negative relationship between MXT with torso height, lower limb length and stature among males are the same as covariance patterns observed among other subarctic samples from the previous two time periods (i.e., after 2500 yBP).

500-100 yBP:

The final time period includes the Yaghan from Tierra del Fuego (though only one other South American site—Cerro Azul) and the Sadlermiut from Southampton Island (in the Hudson Bay). Additionally, the sample also includes most of the southern Northwest Coast samples, and the majority of samples from the Great Plains and southern Mississippi River Valley. As there are a few high latitude samples, and the high-precipitation groups from the Pacific Northwest, analyses will again be conducted with and without them. Note that, although the Tierra del Fuego Yaghan is also a high latitude sample, it will not be excluded from these analyses except for testing specific relationships after the high latitude North American groups are removed.

As in the 1000–500 yBP time period, a great amount of morphological diversity exists in this time period. All morphologies significantly differ among the samples except relative torso height among females. Excluding the high latitude North American samples, absolute torso height ceases to significantly vary among males, and females cease to have significant differences in facial index, upper body width, relative upper limb length/torso height, and bi-iliac breadth. These differences do not change if the Yaghan are also excluded.

Significant bivariate correlations of morphologies with temperature variables and semi-partial correlations with precipitation variables are given in Table 6.21. The trends among all samples from the 500–100 yBP time period mirror those of the 1000–500 yBP time period, with a few notable exceptions. Among males and females, body size (stature and mass) do not covary as strongly with precipitation in the more recent time period. Also, members of neither sex demonstrate significant covariance in facial indices with climate, and females, not males, have a significant covariance in bi-iliac breadth with climate (narrower pelvises in warmer climates). Yet, males have wider upper bodies in warmer climates. Note that, generally, the same patterns of covariance exist between the remaining morphologies and climatic variables during this and the previous time period.

Excluding the arctic and Pacific Northwest high latitude samples, there are notable differences, both in comparison with the entire sample from the 500–100 yBP time period and with previous time periods. Cranial index does not vary among subarctic samples, but cranial module, surprisingly, is *higher* among subarctic samples in warmer and wetter climates, which is an unprecedented relationship and is the opposite of the pattern observed in female body mass. Nasal index remains significantly, positively correlated with warmer temperatures, as does lower limb length and absolute torso height (among females only). Intriguingly, intralimb indices generally are higher in *cooler*, drier climates among the lower latitudes, especially among males. Males also exhibit relatively shorter torsos and upper limbs in warmer locations. Stature does not significantly covary with climate among males, despite a relationship between lower limb length and climate, suggesting that increasing lower limb length is related to slight decreases in torso height, maintaining similar statures among samples in different environments (though statures do vary among samples).

Table 6.21. Significant ($p < 0.05$) correlations of morphologies among 500-100 yBP samples with climatic factors, all regions and subarctic samples considered alone. Strictly significant ($p < 0.01$) relationships are indicated in **bold**. Superscripts indicate a positive or negative correlation. When no climate variable significantly covaries with a morphology, it is designated as “none”. Blank cells indicate morphologies not significantly varying among samples, and not covarying with any climate variables.

ALL REGIONS

		Morphology ¹														
		CRI	CRM	FI	NI	UBW	BI	CI	ATH	LLL	RTH	ULTH	ILI	BIB	BM	ST
♂	MAT ⁺							MAT ⁺	MAT ⁺	MAT ⁺			MAT ⁺			
	MXI ⁺		MXI ⁺		MXI ⁺	MXI ⁺	MXI ⁺	MXI ⁺	MXI ⁺	MXI ⁺	MNT⁺	none	MNT ⁺	none	MXI ⁻	MAT ⁺
	MNT ⁺		none		MNT ⁺	MNT ⁺	MNT ⁺	MNT ⁺	MNT ⁺	MNT ⁺			MNT ⁺		MNT ⁻	MNT ⁺
♀	MAT ⁺							MAT ⁺	MAT ⁺	MAT ⁺			MAT ⁺			
	MXI ⁺		MXI ⁻		MXI ⁺	MXI ⁺	MXI ⁺	MXI ⁺	MXI ⁺	MXI ⁺			MXI ⁺	MAT ⁻	MXI ⁻	MAT ⁺
	MNT ⁺		MTP ⁺		MNT ⁺	MNT ⁺	MNT ⁻	MNT ⁺	MTP ⁺	MTP ⁺			MNT ⁺	MNT ⁻	MNT ⁻	MTP ⁺

SUBARCTIC (not excluding Tierra del Fuego)

		Morphology ¹														
		CRI	CRM	FI	NI	UBW	BI	CI	ATH	LLL	RTH	ULTH	ILI	BIB	BM	ST
♂	none		MAT ⁺	MTP ⁺	MAT ⁺	MAT ⁻	MAT ⁻	MAT ⁻		MXI ⁺	MXI ⁻	none	MAT ⁻	none	MTP ⁺	none
		MNT ⁺			MNT ⁺	MNT ⁻	MNT ⁻	MNT ⁻		MTP ⁺			MXI ⁻			
		MTP ⁺			MTP ⁺											
♀	none		MAT ⁺		MAT ⁺			MAT ⁻	MAT ⁺	MXI ⁺					MNT ⁻	MAT ⁺
		MNT ⁺			MNT ⁺		MTP ⁻	MNT ⁻	MNT ⁺	MTP ⁺					MTP ⁺	MAT ⁺
		MTP ⁺			MTP ⁺			MTP ⁻	MTP ⁺						MTP ⁺	MTP ⁺

¹ CRI, cranial index; CRM, cranial module; FI, facial index; NI, nasal index; UBW, upper body width; BI, brachial index; CI, crural index; ATH, absolute torso height; LLL, lower limb length; RTH, relative torso height; ULTH, upper limb/torso; ILI, interlimb index; BIB, bi-iliac breadth; BM, body mass; ST, stature

An examination of Appendix VI maps demonstrates that many of the aberrant patterns observed are possibly the result of the large sample of groups from the Great Plains (see Figures A6.3.4 and A6.3.7). Indeed, excluding Great Plains samples as well as the high latitude groups yields results that are in keeping with climatic correlations described for the morphologies of 1000–500 yBP samples. Intralimb indices in both males and females, for example, do not covary with temperature, but are higher in drier climates when Great Plains samples are excluded from the subarctic analysis. Stature among males is significantly, positively correlated with MXT and MAT in this instance, as well. It is notable that relative torso height, as expected, negatively covaries with MXT, even without Great Plains males.

Summary of temporal results:

These temporal analyses suggest that morphological variation among samples covaries to some extent with climate, especially when including samples from climatic extremes. There is also evidence that morphological variation and covariation with climate increase over time, but this is likely an artifact of larger sample sizes, greater geographic and genetic diversity, and more climatic variation in more recent time periods. However, general patterns of covariation among morphologies and climate do emerge from these analyses:

Cranial indices: In almost all instances through time, cranial index is higher in locations with warmer overall temperatures and, in more recent time periods, higher precipitation. Nasal index exhibits a similar trend, though is more strongly associated with winter and average temperatures; the earliest samples do not have correlation between nasal index and climate, however. Facial index, generally, does not correlate with climate. These trends are stronger with the inclusion of high latitude and Pacific Northwest samples.

Postcranial indices: Crural indices have more consistent covariance with climate than brachial indices, and almost invariably show relatively longer tibiae in warmer and drier climates. Brachial indices are not as often significantly correlated with precipitation, though relatively longer radii occur in warmer climates. Both indices are more strongly correlated with higher summer temperatures than other temperature variables. Relative torso height has an inconsistent and weak, positive relationship with temperature, namely MNT, but fails to correlate with climate in nearly half the instances it is examined. Likewise, upper limb length relative to torso height demonstrates no relationship with climate with a few exceptional instances. Interlimb index, however, does generally have a positive correlation with climatic variables, especially mean annual temperature and precipitation. All five indices are more consistently correlating with climate when higher latitude samples are included, and often cease to correlate (or sometimes reverse their relationship) when only subarctic samples are included. Often, however, these correlations are not high (see Appendix VI), and in some instances unequal biasing effects of samples from some regions (such as the Great Plains in the most recent temporal periods) affect the observed patterns. It is also noteworthy that the relationships of these morphologies with climate are higher in more recent time periods, and often stronger in males than females. These may be artifacts of sample size and geographic distribution, however.

General morphologies and dimensions: Cranial module and body mass exhibit similar correlations with climatic variables—higher values in colder and wetter environments—which makes sense as these are both measures of body “size.” Bi-iliac breadth, which mostly correlates with climate among males only, is intrinsically

related to body size and, overall, reflects the same pattern relative to temperature. In earlier periods summer temperatures demonstrate a stronger relationship, but with the inclusion of samples from the arctic and South America, this changes to winter extreme temperatures. Upper body width, which also relates to body mass, does not exhibit this consistent relationship with temperatures, often does not vary significantly among samples, and is generally wider only in locations with higher precipitation if it varies. Stature and two of its components—absolute torso height and lower limb length—do not covary strongly with climate among samples from before 2500 yBP, but do have a consistent trend between 2500 and 500 yBP. Including high latitude samples, individuals in warmer environments have taller statures, but in the subarctic, samples in *cooler* environments have greater values for statures and its component measurements. Whether this is the result of confounding effects from subsistence changes will be addressed in the following section.

Perhaps the most apparent result from these analyses is the effect that sample composition can have on patterns of covariance and on morphological variation. For example, note that many of the morphological-climate patterns established for subarctic samples prior to and after the 1500–1000 yBP time period are the same as those from this time period, as this period has no high latitude samples, but instead has a higher concentration of tropical and subtropical samples. In addition, and more importantly, omitting the high latitude samples from the Western Arctic and Central Arctic, as well as the high latitude, high precipitation samples from the Pacific Northwest, often reduces the apparent relationships of climate with morphology. Interestingly, excluding the Great Plains

sample in the most recent time period changes results for many morphologies as well, implicating this region as distinct from other temperate regions in the most recent era.

This latter statement introduces another factor underlying the comparisons made in this section but not directly addressed: geography. Samples likely vary physically as a product of geography as much as of climate. Population mobility (e.g., ranging and migration behavior), sexual selection with neighboring groups, and gene flow are all mitigated by geography. Indeed, many of the morphologies may be covarying with geography as much as they covary with climate, but as climate and geography are inexorably linked, parsing out the relative contributions of each is difficult. Comparing the climatic correlation results with the geographic results shown on the maps in Appendix VI exemplifies this problem. Variations in morphologies relative to climate are not always the same as the patterns observed across geography, but the two generally are similar. One method for addressing this conundrum is to look at variation within regions, through time when possible, as this may take regional factors—such as population history—into account.

6.3.2: Variation within regions (across time periods where applicable)

This section takes a different approach to examining morphological variation in relation to climate by circumscribing the analysis within regions, but aggregating time periods where possible. Two regions are especially important in this latter regard: the Southeastern U.S., and California (combined in this section with the Great Basin). The U.S. Southwest is also regionally unique, in that all of the samples considered for that region were practicing similar (though not identical) forms of agriculture, and generally lived within 500 years of each other. An examination of all regions, however, aids in comprehending the complexity of results from the previous subsection. Bivariate correlations are again used. As in subsection

6.3.1, readers are encouraged to study the maps provided in Appendix VI to aid in understanding the morphological diversity further examined in this subsection.

The Arctic:

The arctic—Western and Central Arctic regions combined—has a sample dating primarily to the last two millennia and consisting of two concentrations of sites, along the western edge of Alaska and around the Hudson Bay area. The oldest samples consist of the two Norton culture skeletons uncovered at Point Hope and, ostensibly⁶, the Pre-Aleut, though only the two Norton culture skeletons are assigned the oldest dates, between 4000 and 2500 yBP. In the 2500 to 1500 yBP time period, Ipiutak culture skeletons from Point Hope and the Pre-Aleut comprise the total sample. After 1000 years BP, the geographic distribution of samples expands to include skeletons from Hudson Bay and a number of sites in western Alaska. The arctic has remained consistently cold and inhospitable throughout these time periods. For this reason, agriculture—even organized horticulture—never developed in the region. Thus, subsistence is largely controlled in the arctic, with the greatest difference existing between groups living on the coast and those who settled along river valleys inland. This potential dichotomy is explored in the subsistence analyses following this subsection.

There is a considerable amount of morphological variation in the arctic among all samples, as shown by aggregated time period in Table 6.22. In the combined time period, males significantly differ, as indicated by a one-way ANOVA, in cranial index, nasal index, upper body width, intralimb indices, interlimb index, relative torso height, lower limb length, body mass, and bi-iliac breadth. Females differ in all of these as well, except upper body

⁶ Coltrain et al. (2006) demonstrated that the Pre-Aleut have an extremely ancient time depth among arctic skeletons, at 4000 yBP. However, this applies to only a handful of individuals, while the majority are dated to between 600 and 1800 yBP.

Table 6.22. Derived morphology variation, within sex and within time period, among arctic samples. Significant differences ($p < 0.01$), after a one-way ANOVA, are indicated with an “X.” Note that morphologies are listed using the same abbreviations as those used in Tables 6.20 and 6.21. Also note that facial index and stature never significantly vary in the arctic, and so are not included in this table.

yBP	Sex	n	Morphology ¹												
			CRI	CRM	NI	UBW	BI	CI	ATH	LLL	RTH	ULTH	ILI	BIB	BM
4000-1500	♂	30				X									
	♀	30					X	X	X		X	X			
1000-100	♂	158	X		X	X	X	X	X	X	X		X	X	X
	♀	127	X	X	X			X	X		X		X		X

¹ CRI, cranial index; CRM, cranial module; NI, nasal index; UBW, upper body width; BI, brachial index, CI, crural index; ATH, absolute torso height; LLL, lower limb length; RTH, relative torso height; ULTH, upper limb/torso; ILI, interlimb index; BIB, bi-iliac breadth; BM, body mass

width, and additionally in absolute torso height and relative upper limb length/torso height.

Within time periods (Table 6.22), some of these differences do not occur, indicating adaptive change, new population movement, or differences in sample sizes between time periods.

Between 4000 and 1500 yBP, most of the variation exists among females, and primarily in intralimb indices and torso height. Males only significantly differ in upper body breadth. These comparisons are effectively only between the Pre-Aleut and the Ipiutak; there is only one of each sex from the Norton culture period at Point Hope. Nonetheless, the differences in torso height and intralimb index among females, and in upper body breadth among males, are interesting. Pre-Aleut females had significantly longer distal limb elements, as well as longer torsos, and Pre-Aleut males had significantly wider torsos (see Appendix V for values). The Aleutian Islands are considerably more temperate than Point Hope. For instance, the MAT along the Aleutian Islands is 4.89 degrees Celsius, whereas it is -3.22 degrees Celsius at Point Hope during this time period. The Aleutian Islands also experienced much greater precipitation: approximately 171 cm versus 37 cm at Point Hope. As there are

only two samples being compared, the relationship of the observed morphological variation to climate, geography, and/or population history is equivocal. All three were likely significantly different between these samples.

In the more recent time period, however, multiple samples and locations make such comparisons possible; the results of bivariate correlations between climatic factors and morphologies are presented in Table 6.23. Males and females generally show identical patterns of covariation between climate and morphology: individuals in warmer locations have rounder crania, relatively wider nasal apertures, relatively and absolutely taller torsos, relatively longer upper limbs (relative to lower limbs), and lower body masses. Note that males in locations with warmer winters and overall climates also exhibit wider upper bodies, higher brachial indices, absolutely shorter lower limbs and narrower bi-iliac breadths. Crural indices do not significantly correspond with any climatic variables. Many of these differences may be the result of differences between the Neo-Aleut and mainland samples, though Games-Howell post-hoc examinations of the one-way ANOVAs comparing morphologies among samples do not consistently indicate that the differences among

Table 6.23. Derived morphology relationships with climate among arctic samples from the last millennium. Strictly significant ($p < 0.01$) relationships are designated in **bold**. Superscripts refer to the directionality of the relationship. Blank cells correspond to morphologies that do not significantly vary among samples. Crural index, which does not significantly correlate with climatic factors in either sex, is not included.

Sex	Morphology										
	CRI	CRM	NI	UBW	BI	ATH	LLL	RTH	ILI	BIB	BM
♂	MAT⁺ MNT⁺ MTP⁺		MAT⁺ MXT⁺ MNT⁺	MAT⁺ MNT⁺	MAT⁺ MNT⁺	MAT⁺ MXT⁺ MNT⁺	MAT⁻ MNT⁻	MAT⁺ MXT⁺ MNT⁺	MAT⁺ MXT⁺ MNT⁺ MTP⁻	MAT⁻ MXT⁻ MNT⁻	MAT⁻ MNT⁻
♀	MAT⁺ MXT⁺ MNT⁺	MTP⁺	MAT⁺ MXT⁺ MNT⁺			MAT⁺ MNT⁺ MTP⁺		MAT⁺ MNT⁺ MTP⁺	MAT⁺ MXT⁺ MNT⁺		MAT⁻ MNT⁻

samples are dichotomous between the Aleut and Inuit. Indeed, precipitation—the greatest climatic difference between the Aleut and mainland samples—has little covariance among the morphologies differing among groups. These results, then, would argue for some relationship between climate and morphological variation within the arctic, even though the region is, generally, cold and dry (with the exception of the Aleutian Islands). Of course, the individuals living in Point Barrow, the Lower Yukon, and Southampton Island were most likely not closely genetically related, and so population history cannot be discounted as also influencing the observed variation.

The Pacific Northwest and the Western Plateau:

Like the arctic, the Pacific Northwest and Western Plateau contain samples as old as the mid-Holocene (not including Kennewick and Gore Creek early Holocene skeletons), and as recent as the last couple of centuries. However, the geographic differences between these temporal periods are considerable. The oldest samples were uncovered in Prince Rupert Harbor, which was occupied nearly 2000 years prior to the sites from Vancouver Island and the Kamloops area. The two regions are composed of starkly different environments, despite their geographic proximity; the Pacific Northwest, as has been repeatedly noted in this chapter, is the wettest environment considered in North America⁷, while the Western Plateau is comparatively dry and considerably cooler (as well as more seasonal). Therefore, contrasting these regions is compelling, but temporally unfeasible except in the most recent time period, represented by three cultures: the Kwakiutl, the Nootka (both which represent the Pacific Northwest), and the Coast Salish (representing the Western Plateau). A practical

⁷ It continues to be the wettest place in North America, with some extreme reports indicating as many as six *meters* of precipitation annually toward the northwestern edge of Vancouver Island. This is more rainfall than falls in some tropical rainforests.

constraint in comparing these groups with each other is the practice of cranial deformation among all of them; comparisons will therefore be limited to the postcrania.

A one-way ANOVA comparing the morphologies of the millennia-old Tshimshian from Prince Rupert Harbor with the recent Kwakiutl and Nootka reveals few significant differences. Males significantly differ in upper body width, brachial index, bi-iliac breadth, and body mass; females significantly differ only in body mass. Male and female Tshimshian were significantly more massive than either the Kwakiutl or Nootka ($p < 0.01$). However, among the other morphologies varying between male samples, the Nootka and Tshimshian significantly differ from the Kwakiutl, with wider upper bodies and bi-iliac breadths, and higher brachial indices. As in the comparisons made between the Pre-Aleut and Ipiutak, it cannot be determined if the differences in body mass and bi-iliac breadth were related to the colder climate in Prince Rupert Harbor, the higher precipitation among the Nootka and Kwakiutl, or population history. It is intriguing to note that the *Kwakiutl*, and not the Nootka, lived in an environment most like that experienced by the Tshimshian (Table 6.24), though the length of occupation by these various cultures in these environments differed substantially (the Tshimshian lived around Prince Rupert Harbor for a considerably longer time period) (Cybulski, 1996).

Table 6.24. Mean climate for the four cultures from the Pacific Northwest and Western Plateau. Note that these are means for multiple sites in all cases, for which individual climate data are listed in Appendix IV.

Sample	MAT (°C)	MNT (°C)	MXT (°C)	MTP (cm)
Tshimshian	7.70	0.06	17.44	327.00
Nootka	9.83	-0.07	21.98	111.32
Kwakiutl	9.25	1.72	17.94	261.27
Coast Salish	9.36	-3.48	24.71	68.66

The differences between the Kwakiutl and Nootka, however, may be further examined in conjunction with the Coast Salish. A one-way ANOVA among these groups continues to show the same differences among the Kwakiutl and Nootka. The Kwakiutl group with the Coast Salish in having narrower bodies (in both upper body and bi-iliac breadths), as well as in having slightly lower body masses and relatively shorter torsos. Interestingly, the Coast Salish males have significantly ($p = 0.024$) higher brachial indices (mean, 78.30) than either the Nootka or Kwakiutl (means, 77.18 and 75.66, respectively). Brachial index is the only morphology differing among females in these groups, and follows the same pattern; Coast Salish females have significantly ($p < 0.01$) higher indices. MXT significantly, positively correlates with brachial index in both sexes ($p < 0.01$), and MAT significantly, positively correlates with relative torso height ($p < 0.05$), but no climatic variables covary with upper body breadth, bi-iliac breadth or body mass. Differences in these latter morphologies among males may be related to population history or subsistence.

The Great Plains and South Texas:

The temporal range of samples from the Great Plains and South Texas extends from 2500 yBP to the last two hundred years. Most samples date to the last millennium, but analyses will be conducted between two aggregated time periods: 2500–1000 yBP, and 1000–100 yBP. Geographically, this is a longitudinally-constrained total sample (all sites fall within 10 scaled degrees longitude), though it covers a considerable latitudinal range, from the Souris River Valley in central southern Manitoba to the coast of Texas and the Rio Grande, in both aggregated time periods.

It should also be noted that this sample contains most of the contributed samples from the EOD, namely the measurements provided by Dr. Daniel Wescott. These data add to analyses

comparing intra- and interlimb indices, lower limb length, and body mass. EOD data, however, do not have climate data formulated, only geographic locations. Analyses of morphological variation within the Great Plains are therefore limited to the POD in this subsection to ensure correspondence of results comparing morphological variation among groups and bivariate correlations of those morphologies with climatic variables.

Furthermore, one-way ANOVAs show similar results with and without the additional samples from the EOD for males and females. This is reassuring, as some of the patterns of variation present in the POD and EOD sample are represented in the climate comparisons with the POD alone.

Results for one-way ANOVAs comparing morphologies among POD samples yield different results for males and females. Males across all time periods significantly ($p < 0.01$) differ in cranial index, cranial module, nasal index, crural index, interlimb index, and body mass, and less restrictively ($p < 0.05$) in upper body width, relative torso height, and bi-iliac breadth. When compared within aggregated time periods, males from 2500–1000 yBP significantly differ only in cranial index and body mass, while more recent males significantly differ in all of the morphologies listed except for relative sitting height. This temporal difference is, in part, a consequence of limited sampling from the earlier time period (four samples from the POD). Examining these samples separately is important, though, as early variation on the Plains may be swamped out by the patterns among more recent samples. Females in the POD only significantly ($p < 0.01$) differ in cranial index, cranial module, and nasal index, crural index, and body mass in the last millennium, and only cranial module and nasal index in the 2500–1000 yBP time period.

Significant correlations between climatic variables and morphologies in aggregated time

periods are reported in Table 6.25. Among the four samples from the 2500–1000 yBP temporal period, males in locations with cooler climates have narrower bi-iliac breadths, and females in warmer climates have larger crania. These relationships are likely reflective of the climatic differences between samples from southern Manitoba and southern Texas, and so it is not feasible to rule out the possibility that the differences are the result of population history and not climate (however, it is notable that most morphologies do not differ considerably between these samples). In the samples from the last millennium, however, these trends are mirrored. Both males and females in warmer, drier climates have larger crania (as well as relatively wider nasal apertures among males), contrary to the pattern for body mass (which is the same as the male pattern for bi-iliac breadth in the previous time period). Again, this might be the bias of differences between the northern Plains and the

Table 6.25. Derived morphology relationships to climate among Great Plains and South Texas samples. Strictly significant ($p < 0.01$) relationships are designated in **bold**. Superscripts refer to the directionality of the relationship between the morphology and the exogenous factor. Blank cells correspond to morphologies that do not significantly vary among samples.

yBP	<i>n</i>	Sex	Morphology								
			Cranial index	Cranial module	Nasal index	Upper body width	Crural index	Interlimb index	Bi-iliac breadth	Body mass	
2500-1000	23	♂	none							MAT ⁻ MXT ⁻ MNT⁻	
	15	♀		MAT ⁺	none						
1000-100	79	♂	none	MAT ⁺ MNT ⁺ MTP⁻	MAT ⁺ MNT ⁺ MTP⁻	MXT ⁻	none	none	none		MAT ⁻ MXT ⁻ MNT ⁻ MTP⁺
	60	♀	none	MAT⁺ MNT⁺ MTP⁻	none		none				MAT ⁻ MXT ⁻ MNT ⁻ MTP ⁺

coastal Texas samples from this period. The concordance of the patterns between the two periods may suggest that the samples from the southern Plains tended to have overall larger crania and lower body masses. A consultation of the body mass plots in the Appendix VI maps demonstrates that the latter is the case in both time periods. It is interesting, though, that postcranial and cranial proportions, on the whole, do not covary with climatic factors among these samples, despite significant differences in these morphologies among them and their geographic latitudinal range. Intralimb indices (A6.2.1 and A6.3.1) are generally in the higher quintiles for all groups in the Plains, as well as nasal indices (A6.1.1), though bi-iliac breadths are generally wider and relative torso heights shorter for all samples. None of these significantly correlate with climatic factors. This lack of correspondence between climatic variables and morphologies among the samples from the Plains could further emphasize their uniqueness in relation to other temperate regions from the last millennium, and could, furthermore, be used to argue that these populations were generally late arrivals in the region or, at least, did not show the relationships with climatic factors already indicated by examining temporal variation. Comparisons among other temperate regions will reveal if this argument is justified.

The Prairie and Eastern Woodlands:

Where the Great Plains are longitudinally constrained, the Prairie and the Eastern Woodlands are restricted in latitude. This region comprises a sample extending from the Illinois River Valley to the east coast of North America, including sites located in the Ohio and Delaware River Valleys, as well as skeletons from Cape Cod and the southeastern coast of Maine (near to Vinalhaven). Only two sites (Modoc Rock Shelter and Donaldson) date to the oldest period represented in this sample, 4000–2500 yBP, and both have small samples.

(Furthermore, as noted in the temporal analyses of the last subsection, the climate data for the Donaldson site are unfortunately inestimable, and so these skeletons are not included in this analysis either.) Given the sample restriction, these samples are combined in analyses with samples from the Woodland period (2500–1000 yBP). Much of the Woodland sample from this region is dominated by Hopewell sites from western Illinois, though the Libben site, located along the southwestern shore of Lake Eire, is also from this time period. Samples from the last millennium include Mississippians from central Illinois and southern Ohio (some of their crania exhibit cranial deformation, and are therefore excluded from analyses of cranial variation), in addition to samples from the Delaware River Valley and the northeastern coast of the U.S.

Variation among males exceeds the morphological diversity found among females in the 4000–1000 yBP time period, but is similar between the sexes during the last millennium (Table 6.26). Despite significant differences among males and females in cranial module and nasal index in the 4000–1000 yBP time period, neither significantly covaries with climatic factors. Among male samples from the last millennium, however, cranial index is positively

Table 6.26. Morphologic variation, by sex and within aggregated time period, among Prairie and Eastern Woodland samples. Significant differences ($p < 0.01$), after a one-way ANOVA, are indicated with a bold “X,” and those varying under less restrictive significance ($p < 0.05$) are marked with a plain text, lower case “x.” Note that morphologies are listed using the same abbreviations as those used in Tables 6.22 and 6.23. Also note that facial index, crural index, and body mass never significantly vary among these groups, and so are not included.

yBP	Sex	Morphology											
		CRI	CRM	NI	UBW	BI	ATH	LLL	RTH	ULTH	ILI	BIB	ST
4000-1000	♂		X	x	x	X		X		x		x	X
	♀		x	x		X		x					
1000-100	♂	X		x					x	X		X	
	♀	X	x				X		X	X	x		

correlated with all three temperature variables and precipitation (MXT, MAT and MTP, $p < 0.01$; MNT, $p < 0.05$), and nasal index is higher among males in warmer, drier climates (MXT and MTP, $p < 0.05$; MAT, $p < 0.01$). The same trend is evident among females in cranial index (MXT, MAT and MTP, $p < 0.01$), but there no covariance between cranial module and climatic variables persists among female samples from the last thousand years. As shown in Table 6.26, nasal index does not significantly vary among females in the latter time period.

Postcranial relationships with climatic factors are summarized in Table 6.27. Among the Late Archaic and Woodland samples, males in cooler climates tend to have higher brachial indices and shorter statures, but no other postcranial morphologies significantly covary with climatic factors among the males or females in the earlier time period. Male samples from the last 1000 years exhibit wider bi-iliac breadths in warmer and drier locations, and female

Table 6.27. Postcranial morphology and climate among Prairie and Eastern Woodland samples. Strictly significant ($p < 0.01$) relationships are designated in **bold** type. Superscripts refer to the directionality of the relationship between the morphology and climatic factors. Blank cells correspond to morphologies that do not significantly vary among samples.

yBP	Sex	Morphology								
		Upper body width	Brachial index	Absolute torso height	Lower limb length	Relative torso height	Upper limb length/torso height	Interlimb index	Bi-iliac breadth	Stature
4000-1000	♂	none	MAT⁻ MXT⁻ MNT⁻		none		none		none	MAT⁺ MXT⁺ MNT⁺
	♀		none		none					
1000-100	♂					none	none		MAT⁺ MXT⁺ MTP⁻	
	♀			MAT⁺ MXT⁺		MAT⁺ MXT⁺	MNT⁻	MAT⁻ MNT⁻		

samples have relatively and absolutely taller torsos in locations with warmer summers, as well as relatively shorter upper limbs in locations with warmer winters. No other morphologies significantly correlate with climatic factors. As this region is entirely temperate (mean annual temperatures range between 7.4 and 19.1 degrees Celsius), any covariation between morphologies and climate is interesting, though difficult to interpret. Note that covariation of cranial morphologies matches the general patterns for the Americas, as does torso height in recent females, but male brachial index between 4000 and 1000 yBP, as well as male bi-iliac breadth and female upper limb length in the last millennium do not.

The Southeastern U.S.:

The Southeastern U.S., of all of the regions considered in this subsection, is considered the most important to investigating regional variation in relation to climate and geography. It is the only region to have samples consisting of multiple individuals dating from the majority of the Holocene. It also extends from the subtropical Floridian peninsula to the temperate woodlands of the Tennessee River Valley, as well as including groups living on the margins of the southern Mississippi River Valley. Nearly one-fourth of the POD, as noted in Chapter 4, is included in the sample for this region, and so it likely has the most potential biasing influence on analyses that exclude samples from the arctic and Pacific Northwest. Despite the great temporal range of this region, comparisons are still made using three aggregated time periods to maximize the geographic range represented in comparisons (e.g., the 2500–1500 yBP time period consists of only samples from Florida).

Comparisons are made across all time periods together, as well as in the aggregated time periods. Given the time depth available in this region, this contrast is made to assess if the significant relationships between morphology, climate and geography are more evident when

multiple time periods are assessed simultaneously, and if these are consistent to findings within time periods or change over time (i.e., if morphologies demonstrate more or less relationship with climate over time). Naturally, much of the difference between the results of these may simply be attributable to sample size, geographic and climatic distribution, and significant temporal variation, but is nevertheless informative.

Significant differences among samples occur in most of the derived morphologies when considering all time periods combined, but are not the same as those observed within time periods. Table 6.28 presents the results of one-way ANOVAs comparing derived morphologies among samples, within and across aggregated time periods. It is notable that no morphologies are consistently significantly variable across all time periods, and some only differ when considering all time periods together (i.e., facial index, absolute torso height, crural index, or relative upper limb length/torso height). Indeed, variation within aggregated time periods is limited, and far less than the variation observed in the arctic or even the Prairie and Eastern Woodlands for similar temporal periods.

Results from bivariate correlations comparing morphology with climate are reported in Table 6.29. In the aggregated sample from all time periods, only some morphologies covary in relation to climatic factors similarly to the general patterns observed for the subarctic temporal analyses. Namely, cranial index is higher in overall warmer and wetter climates, body mass (as well as cranial module and bi-iliac breadth) is greater in colder and wetter climates, upper body breadth positively covaries with precipitation, and stature (and its component dimensions) is greater in cooler and wetter locations. The general lack of covariance of crural index with climatic factors (only significantly related to precipitation among males), and the negative correlation between temperature and brachial index,

Table 6.28. Significant variation in morphologies among Southeastern U.S. samples, across all time periods and within aggregated times, by sex. Significant differences ($p < 0.01$), after a one-way ANOVA, are indicated with a bold “X,” and those varying under less restrictive significance ($p < 0.05$) are marked with a plain text, lower case “x.”

yBP	Sex	Derived morphology ¹														
		CRI	CRM	FI	NI	UBW	BI	CI	ATH	LLL	RTH	ULTH	ILI	BIB	BM	ST
All time periods	Males	X	x		X	X	X	x	X	X	X	X	X	X	X	X
	Females	X	x	x		X			X	X			X	X	X	X
8000 – 4000	Males	X	x				X						X		X	x
	Females	X					X						X		X	
4000 – 1500	Males	x												x		
	Females	x				x									X	
1000 – 100	Males				X	X	x									
	Females				x								x			

¹ Abbreviations: CRI, cranial index; CRM, cranial module; FI, facial index; NI, nasal index; UBW, upper body width; BI, brachial index; CI, crural index; ATH, absolute torso height; LLL, lower limb length; RTH, relative torso height; ULTH, upper limb length/torso height; ILI, interlimb index; BIB, bi-iliac breadth; BM, body mass; ST, stature

Table 6.29. Correlation results for temporal analyses of climate in relation to morphologies among Southeastern U.S. samples. Superscripts (+ or -) designate the directionality of the relationship. Blank cells reflect morphologies that do not significantly differ among samples in that time period, and cells marked “none” reflect morphologies that *do* vary among samples but have no significant relation with climatic factors. **Bolded** factors have strict significance ($p < 0.01$).

yBP	Sex	Morphology ¹														
		CR1	CRM	FI	NI	UBW	BI	CI	ATH	LLL	RTH	ULTH	ILI	BIB	BM	ST
All time periods	Males	MAT ⁺ MNT ⁺ MTP ⁺	MX ^T ⁻		none	MX ^T ⁻ MTP ⁺	MAT ⁻ MNT ⁻	MTP ⁻	MX ^T ⁻ MTP ⁺	MX ^T ⁻	MTP ⁺	none	none	MX ^T ⁻ MTP ⁺	MX ^T ⁻ MTP ⁺	MX ^T ⁻ MTP ⁺
	Females	MAT ⁺ MNT ⁺ MTP ⁺	none	none	MX ^T ⁻ MTP ⁺			MX ^T ⁻ MTP ⁺	none		MTP ⁺		MAT ⁻ MNT ⁻	MX ^T ⁻ MTP ⁺	MX ^T ⁻ MTP ⁺	MX ^T ⁻ MTP ⁺
8000 – 4000	Males	MAT ⁺ MX ^T ⁺ MNT ⁺	MAT ⁻ MX ^T ⁻ MNT ⁻				MAT ⁻ MNT ⁻ MTP ⁻			MAT ⁺ MX ^T ⁺ MNT ⁺			MAT ⁺ MX ^T ⁺ MNT ⁺		MAT ⁻ MX ^T ⁻ MNT ⁻ MTP ⁻	MAT ⁻ MX ^T ⁻ MNT ⁻
	Females	MAT ⁺ MX ^T ⁺ MNT ⁺ MTP ⁺					MAT ⁻ MNT ⁻ MTP ⁻				none		MAT ⁺ MX ^T ⁺ MNT ⁺		MAT ⁻ MNT ⁻ MTP ⁻	MAT ⁻ MX ^T ⁻ MNT ⁻ MTP ⁻
4000 – 1500	Males	MAT ⁺ MNT ⁺												none		
	Females	none								MX ^T ⁻					MAT ⁺ MNT ⁺ MTP ⁺	
1000 – 100	Males				none	MX ^T ⁺ MTP ⁻	MAT ⁺									
	Females				none	MX ^T ⁺										MAT ⁻ MNT ⁻

¹ Abbreviations: CR1, cranial index; CRM, cranial module; FI, facial index; NI, nasal index; UBW, upper body width; BI, brachial index; CI, crural index; ATH, absolute torso height; LLL, lower limb length; RTH, relative torso height; ULTH, upper limb length/torso height; ILI, interlimb index; BIB, bi-iliac breadth; BM, body mass; ST, stature

contrasts with the general trends. Also, the lack of covariance of nasal index with climate across all time periods is noteworthy.

Comparing results within and across aggregated time periods indicates that these results for combined time periods are likely not the result of sample bias. Most of the morphology trends relative to climate are consistent between the earliest temporal period (8000–4000 yBP) and all time periods combined. Cranial indices are higher in warmer and wetter locations, brachial indices are lower in warmer (but drier) environments, and both stature and body mass (as well as male cranial module) are greater in cooler climates. This time period consists of three samples—Windover, Indian Knoll, and Eva—and therefore is generally a comparison focusing on the cooler Windover sample and the relatively drier Eva sample, though all three locations were considerably warm (MAT, 12.9 to 16.9 degrees Celsius). When the sample is geographically expanded in the 4000–1500 yBP aggregated time period, however, morphologies generally do not significantly differ among samples or covary with climatic factors. This is interesting, as more samples (two from Florida and four from the Tennessee River Valley) representing greater climatic diversity (MAT, 14 to 22 degrees Celsius) comprise these time periods. More morphological diversity and climatic covariation occurred among Indian Knoll, Eva, and Windover, though these sites admittedly represent a far greater temporal dispersion. Yet, in the last millennium, which includes samples from the lower Mississippi River, the Georgia Coast, and Mississippians from central Tennessee, morphological variation remains lower. Males and females in warmer climates exhibit broader upper bodies and longer lower limbs, as well as higher brachial indices among males and relatively shorter upper limbs among females. Nasal index, however, though significantly different among samples, does not covary significantly with climatic variables.

Together, these results demonstrate that the patterns evident between climate and morphology across all time periods in the Southeastern U.S. are not likely the result of sample biases from any single time period. More skeletons are present in the most recent time period ($n = 297$) than the earliest ($n = 167$), as well as greater climatic diversity in the more recent time periods, yet morphological diversity and covariation with climate decreases in more recent periods. Thus, it may also be concluded that it is the aggregated lower latitude sample that is yielding the general trends observed in the subarctic temporal analyses, and not likely the effects of any single region (with the noted exception of the Great Plains). It is interesting, as an aside, to point out that as a rule stature does not significantly vary among samples within temporal periods, but does across them. As the three temporal periods reported in Tables 6.28 and 6.29 represent relative subsistence homogeneity (hunter-gatherers in the oldest temporal periods, followed by horticulture and agriculture in the most recent), it is possible that the variation observed is in part a product of subsistence.

The U.S. Southwest:

The U.S. Southwest presents a unique case in which to assess variation in morphology in relation to climate and geography, without the effects of time or subsistence as factors. This is because of the nature of the Southwest sample used: the sites sampled date from the last millennium (Time Periods 1 and 2), and all sampled populations practiced highly organized subsistence agriculture (though there was cultural variation in the length of time organized agriculture had been practiced, what crops were cultivated, and in food production techniques). In addition, the climates of the southwestern sites examined were constrained relative to the climatic range covered within the total sample (see Table 6.2). Therefore, analyses of the U.S. Southwest portion of the total skeletal sample may be the best

opportunity to determine if exogenous effects other than climate and subsistence might be contributing to the morphological variation of humans in the Americas.

Cranial morphology significantly varies among Southwest samples in cranial index, cranial module, and nasal index. As many of the skeletons from the Southwest present cranial deformation, and as the crania utilized in examining variation in cranial index and cranial module are limited to those without deformation, the significant differences among samples in these two derived morphologies are not representative of the available regional sample (99 crania out of 303 measured crania, or 474 measured skeletons). However, nasal indices are more representative of the available regional sample (266 crania), and do have a significant correlation with MNT among males ($r = 0.320, p < 0.01$) and females ($r = 0.244, p < 0.01$). Facial index does not significantly vary among the Southwest skeletons.

Like variation among cranial morphologies, most of the postcranial morphologies do not significantly vary among Southwest samples. After a one-way ANOVA, relative torso height varies significantly among male samples ($p < 0.01$), body mass significantly varies among female samples ($p < 0.01$), and both stature and crural index vary significantly for males and for females among samples ($p < 0.01$). Intriguingly, brachial index does not significantly differ among samples, and it does not correlate significantly with crural index. Crural indices significantly, positively correlate with all temperature variables among male samples ($r > 0.2$), but not for females. Body mass correlates significantly with MNT for both sexes ($r = 0.201$, males; $r = 0.251$, females). Relative torso height and stature, however, do not correlate with any climatic factors.

Even in the general climatic homogeneity of the U.S. Southwest, minor ecogeographic trends appear. As shown on the continental scale, narrower nasal indices among U.S.

Southwest samples correlate with lower winter temperatures, as well as male crural indices. Nasal indices, however, do not correlate with increases in mean warmest month high temperatures. Counter-intuitively, body masses are greater among U.S. Southwestern peoples living in climates with warmer winters. Were this an indicator for milder climates—a conjecture supported by the positive correlation of mean annual precipitation and warmer winters ($r = 0.229$)—the greater body masses may be related to greater food production or availability.

Admittedly, the correlation coefficients are low for these ecogeographic patterns. Plotting sample means of the morphologies against climatic variables reveals one potential factor that is contributing to the observed differences among samples—population history. Crural index variation among males most clearly demonstrates this (Figure 6.4.1). This graph demonstrates that crural indices are higher for males living to the west of the Continental Divide than for males east of the divide, and also that climatic factors are not a clear discriminator among intralimb indices. Note that, although the ANOVA assessing crural index among samples revealed a significant difference among males in the Southwest, the Games-Howell post-hoc test only discerned a significant difference between the two samples at the extremes: Puye, New Mexico (mean crural index, 84.54) and Glen Canyon, Utah (mean crural index, 86.68). Thus, though there is clearly a pattern in crural indices among males in the Southwest—one which may be biologically significant—it does not vary enough to reach statistical significance. This pattern for crural indices also exists for females, with two notable exceptions. Mimbres females (mean crural index, 86.36), despite having lived on the eastern side of the Continental Divide (in southwestern New Mexico along the modern Mexican border), have very high crural indices, and the small female

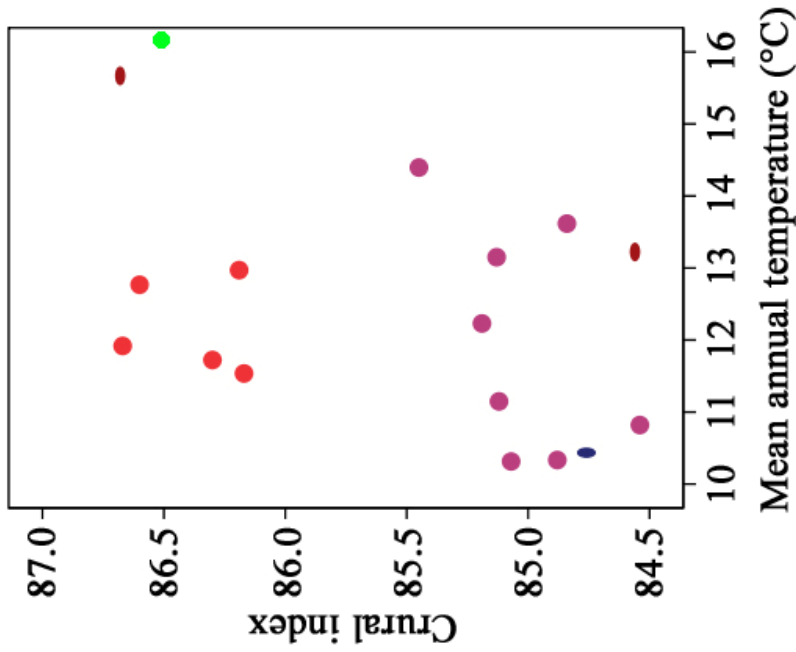


Figure 6.4.1. Male crural index versus mean annual temperature in the U.S. Southwest. Red circles, samples located in Arizona; purple circles, samples located in New Mexico; blue oval, Ackmen sample (Colorado); dark red ovals, Utah sites (Glen Canyon and Duna Leyenda). The green circle represents the Yuma sample from southern California.

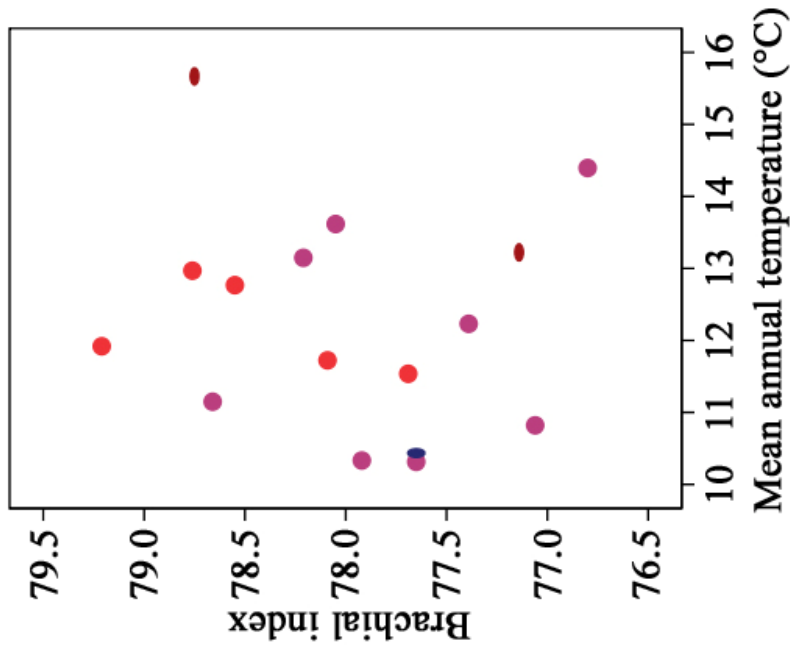


Figure 6.4.2. Male brachial index versus mean annual temperature in the U.S. Southwest. Symbols are the same as those used in Figure 6.4.1. The southern California Yuma sample is not depicted in this figure.

sample from Carter Ranch exhibits relatively low crural indices (mean crural index, 83.77) similar to those observed among the majority of groups living east of the divide. No other derived morphologies for either sex demonstrate this west-east separation as clearly as crural indices, though brachial indices indicate a tendency for males west of the divide to have relatively longer forearms (Figure 6.4.2).

It may be that the differences in crural index reflect population history more than climatic adaptation, especially if the groups living in the U.S. Southwest had not lived in the region for a long period of time, or were not under selective pressures. This will be considered further in the Discussion. Before deferring this topic, it should be added that when the Yuma⁸ from southern California are included in the scatterplot of crural index against MAT (Figure 6.4.1), they plot with the other groups from west of the Continental Divide (Yuma male crural index, 86.55; Yuma female crural index, 86.27). Again, this pattern exists despite similar climatic conditions on both sides of the Continental Divide.

The Great Basin and California:

The last two regions considered in North America, the Great Basin and California, have characteristics similar to both the Southeastern U.S. and the U.S. Southwest. Temporal ranges of samples from these two locations constitute most of the length of the Holocene, as found in the Southeastern U.S. However, like the U.S. Southwest, these regions are separated by a mountainous geographic barrier. Ideally, these two regions would permit further examination of the potential effects this geographic divide has on morphological

⁸ The Yuma are regarded as a bridging population between southern California groups and the U.S. Southwest, based on trade networks and occupied territory. Although they were not as dedicated to agriculture as the other samples from the U.S. Southwest, they did engage in floodplain agriculture and raised maize, among other crops, in addition to migrating seasonally to exploit various resources. They likely descended from the Patayan culture (Reid and Whittlesey, 1997). The origins of the Patayan, however, remain contested, though it is likely that they emerged from the Sonoran Desert or farther south.

variation through time. Due to the nature of burial practices in the Great Basin, however, such comparisons are restricted to the most recent time periods (Caldwell Village, Evans and surrounding sites, and the Polley-Secret site), when samples consisting of multiple individuals are available for analysis.

Across all time periods after 8000 yBP, variation in these two regions remains the same with and without inclusion of the Great Basin samples, though this is indubitably a biased result of the much larger sample from California in the total sample. Temporal periods are, once more, aggregated for analytical purposes into three groups, of which only the most recent contains a comparison of the Great Basin and California samples. One-way ANOVA results assessing sample variation in morphologies are reported in Table 6.30. Note that, despite the inclusion of a geographically broader sample in the most recent time period (both the Great Basin and California samples), variation is generally less than in the previous time

Table 6.30. Significantly varying derived morphology variation, by sex and within time period, among Californian samples, and for Californian and Great Basin samples dating to the last millennium. Significant differences ($p < 0.01$), after a one-way ANOVA, are indicated with a bold “X,” and those correlated under less restrictive significance ($p < 0.05$) are marked with a plain text, lower case “x”.

yBP	Sex	Morphology ¹									
		CRI	CRM	NI	CI	ATH	LLL	ILI	BIB	BM	ST
8000 – 4000	Males	X	X			X	X	X	X	X	x
	Females	x		X		X	X	x		X	X
4000 – 1500	Males	x	x		x			x		X	
	Females	X	x				X			X	
1000 – 100	Males	X		x			x			x	
	Females		X	X			x				

¹ Abbreviations: CRI, cranial index; CRM, cranial module; NI, nasal index; CI, crural index; ATH, absolute torso height; LLL, lower limb length; ILI, interlimb index; BIB, bi-iliac breadth; BM, body mass; ST, stature

periods, especially the oldest time period. However, the 8000–4000 yBP time period consists of samples extending from the northernmost area of Baja California and the Channel Islands to the northwestern Sierra Nevada range (the Karlo site) to the east and the San Francisco Bay to the west, and so also includes a broad geographic range.

Table 6.31 summarizes the results for morphological comparisons with climate and geographic factors. Variation among both males and females from the earliest time periods is reflective of variation in body size: taller individuals are correlated with cooler and wetter environments (e.g., the San Francisco Bay area), as well a more massive (and in the case of males, wider) individuals. This trend continues in the subsequent temporal period (4000–1500 yBP), although samples significantly differ in body mass (reflected as well by cranial

Table 6.31. Correlation results for temporal analyses of climatic factors in relation to derived morphologies among Californian and, in the case of the last millennium, Great Basin samples. Superscripts (+ or –) designate the directionality of the relationship. Blank cells reflect morphologies that do not significantly differ among samples in that time period, and cells marked “none” reflect morphologies that *do* vary among samples but have no significant relation with a climatic or geographic factor. **Bolded** factors have strict significance ($p < 0.01$). Abbreviations are the same as those used in Table 6.30.

yBP	Sex	Morphology									
		CRI	CRM	NI	CI	ATH	LLL	ILI	BIB	BM	ST
8000 – 4000	Males	none	none			MAT⁻ MTP⁺	MAT⁻	none	MAT⁻	MAT⁻ MXT⁻	MAT⁻ MTP⁺
	Females			none		MAT⁻ MTP⁺	MAT⁻	none		MAT⁻ MXT⁻	MAT⁻ MTP⁺
4000 – 1500	Males	none	MAT⁻ MTP⁺		none			MTP⁻		MAT⁻ MNT⁻ MTP⁺	
	Females	MNT⁺	MAT⁻				none			MAT⁻ MTP⁺	
1000 – 100	Males	MAT⁻ MNT⁻		none				MNT⁺		MNT⁺	
	Females		MAT⁺ MNT⁺ MTP⁺	none				none			

module) but not stature. Note that females in locations with warmer winters have rounder crania. This muted variation in this middle aggregated temporal period is likely, in part, the result of a more geographically circumscribed total sample.

Comparisons among samples from California and the Great Basin dating to the last millennium are interesting, as they indicate that geography, and not climate, likely relates to the differences in some of the morphologies. Males with narrower crania, longer lower limbs and higher body masses (implicated for females as well) are correlated with warmer climates. A crucial point to be made here is that both temperatures and precipitation differed considerably between the Californian and Great Basin samples; California sites experienced higher mean temperatures and higher precipitation. For example, Great Basin sites, when averaged, experienced a mean annual temperature of 9.93 degrees Celsius, while the California sites from the same time period had averaged mean annual temperatures of 15.79 degrees Celsius. Compare also the mean MTP for the Great Basin at approximately 24 cm, versus the 56 cm that fell on the California sites. Thus, although some morphologies are significantly correlated with climatic factors, it is equally possible that the differences among the groups in these two regions arose from climate, population history, or a combination of these factors. It is compelling, however, that in both regional comparisons involving the Continental Divide, differences in some morphologies are potentially related to geography, although few morphologies significantly vary between the two regions.

South America:

After considering North American regions, some attention should also be focused on the samples from South America. Including the data from the EOD, the South American sample extends—mostly along the west coast—from central Ecuador to Tierra del Fuego. In order

to capture this geographic distribution, all time periods from South America (approximately from 2500 yBP to the last two centuries) are combined in this analysis. Note that the southernmost samples—the Gran Chaco/Patagonia region of Argentina and the Yaghan from Tierra del Fuego—only add data for intra- and interlimb indices, body mass, and bi-iliac breadth; climate data are available for these samples.

The results of a one-way ANOVA comparing all of these samples, intriguingly, only indicate that nasal index, lower limb length, and interlimb index significantly vary among samples in both sexes, and that brachial and crural indices significantly vary only among *females* ($p < 0.01$). As vertebral measurements were only possible among the groups from Peru and Ecuador, the lack of variation in the dimensions that incorporate their dimensions is not surprising. Likewise, craniometrics were only obtained from the Peruvian and Ecuadorian samples. Body mass, bi-iliac breadth, and limb dimensions are available from all of the samples, however. Therefore the general lack of variation among these, despite a considerable geographic range, is intriguing. A reexamination of the Appendix VI maps for these morphologies shows that these morphologies all tend to be moderate to “warm” in their ranges, though there are notable exceptions, even in bi-iliac breadth and body mass (namely,

Table 6.32. Correlation results for temporal analyses of climatic factors in relation to derived morphologies among South American samples. Superscripts (+ or –) designate the directionality of the relationship. Cells marked “none” reflect morphologies that *do* vary among samples but have no significant relation with a climatic or geographic factor. **Bolded** factors have strict significance ($p < 0.01$).

yBP	Sex	Derived morphology				
		Nasal Index	Lower limb length	Brachial index	Crural index	Interlimb index
2500 – 100	Males	MAT⁺ MXT⁺	MTP⁺		MTP ⁻	none
	Females	MAT⁺ MXT⁺	MTP⁺	MAT⁺ MXT⁺ MNT⁺	MAT⁺ MXT⁺ MNT⁺	MAT⁻ MXT⁻ MNT⁻

the Yaghan from Tierra del Fuego).

Table 6.32 presents the results of comparisons made between the significantly varying morphologies and climate. It is interesting that bi-iliac breadth and body mass do not significantly vary among the samples, and do not correlate with any climatic factors. Nasal indices are higher among groups living in the warmer climates, which is interesting as this comparison is only among samples from the northwestern regions of South America. The significant correlation between precipitation and lower limb length is most likely an effect of the comparison of samples from comparatively wet Gran Chaco/Patagonia region (the Toba), who have very long lower limbs (male average, 806.8 mm) with the rest of the samples in South America; the samples from the Nasca Desert (male mean, 779.95 mm), for example, are the closest samples to the mean length of the Toba's lower limbs. The Toba also have moderately low brachial and crural indices (females, brachial index mean, 76.3; crural index mean, 85.67), with lower indices found among the Yaghan (females, brachial index mean, 75.6; crural index mean, 81.9). Each of these samples, however, have indices much lower than those found in central western Peru and Ecuador, both of which have much warmer climates. Interestingly, males do not demonstrate this pattern in intralimb indices. In fact, Yaghan and Toba males have much *higher* brachial indices than all other samples except the tropical Ayalán, though these two southernmost samples' males have moderate crural indices (84.65, Yaghan; 84.49, Toba).

The lack of correlation in body mass and bi-iliac breadth with climate is an especially curious point, as previous research among living populations (Stinson, 1990) has indicated a weak latitudinal cline in body breadth. An examination of the pertinent maps (A6.5.1 and A6.6.1) elucidates why this pattern is not evident. Namely, even though they were located in

what has been described as a “harsh” climate, the Yaghan are characterized as having moderate to narrow body breadths (relative to the entire American sample), and generally lower body masses than many other groups. Compare, for example, the mean body mass and bi-iliac breadth of the females in the Yaghan and Toba samples (Appendix V – Part B). The Toba were notably heavier and wider-bodied, despite living in a more temperate environment. However, it is worth noting that the Yaghan lived in a climate not too dissimilar from the Neo-Aleut, and so the expectation that they would have morphologies similar to the Inuit would be evoking morphologies retained from population history, and not climatic adaptation.

This is a compelling comparison, as the only significant difference in climate between the Aleutian Islands and Tierra del Fuego Island is precipitation; the Aleutian chain is generally wetter. A one-way ANOVA comparing the Neo-Aleut and the Yaghan for differences in morphology indicated that, among males, the only significant differences are in brachial and crural indices. The Yaghan males have higher intralimb indices (e.g., mean male brachial index is 79.63, and female mean brachial index is 75.60), which belie the hypothesis that these groups would be similarly adapting to their climates. Among females, however, only body mass significantly differs, with the Neo-Aleut on average six kilograms more massive. One might take this as persuasive evidence for morphological adaptation to the same environmental factors. These two groups unquestionably are of separate but recently shared genetic and population histories and have very similar morphologies. However, these are but two extreme examples among the many explored in this subsection. In addition, one other set of factors was held in common between these two subarctic groups and is explored in the next section—dietary subsistence.

Summary of regional climatic analyses:

In general, the regional analyses demonstrate similarity among many morphologies within comparable temporal periods, with the majority of variation occurring in cranial indices (cranial index and nasal index) and body size dimensions. Indeed, within regions, cranial index rarely significantly varies and generally does not covary with climate, though brachial index does tend to vary more often. Similarly, relative torso height seldom varies among samples. It is interesting to note that the arctic has considerable variation, whereas the Southeastern U.S. and U.S. Southwest are relatively homogeneous. Climatic correlations with morphological variation are, unsurprisingly, greater with more geographic representation, but are not altogether absent within circumscribed regions. The comparison of morphologies among samples in the Southeastern U.S. also demonstrates that time may be as significant as interregional differences in influencing the amount of morphological variation, and reinforces the caution stated at the beginning of this section: aggregating temporal periods increases observed morphological variation and changes patterns when comparing this variation with climatic factors. Finally, these regional analyses confirm the possibility that population history and geography *do* influence some of the patterns of morphological variation, especially when considering large geographic divisions (e.g., islands versus mainland, or separation by mountain ranges).

6.4: Patterns of morphological variation in relation to subsistence

Much analysis in this chapter has been devoted to climatic variation, morphological variation, and the relationship between these variables. However, it is clear that some morphological variation is not correlated with climate or geography unless compared across long time periods or among geographically broad samples. For example, note that stature,

despite corresponding to temperature and precipitation in continent-wide temporal analyses, by and large does not significantly vary within time periods in regional analyses. Under the cylindrical model (see Chapter 3), stature should have no effect on the surface area-to-mass ratio of the body, and therefore not enter into the thermoregulatory model that is behind much of the expected relation of morphological variation to climatic factors. Rather, as presented in the hypotheses, stature (among other dimensions) is expected to vary in relation to modes of dietary subsistence.

This section considers these relationships, both with and without taking climate into account. A general assessment of variation in relation to subsistence across all time periods and regions is initially conducted, under the assumption that subsistence modes will affect morphologies in the same way, regardless of time or location. Subsequent analyses, mirroring the analyses of climate, examine the relationship of morphology to subsistence modes over time and across regions—before widespread horticulture, during the transition to agriculture, and after the pervasive adoption of agriculture in North America—and then briefly consider variation within regions. Two additional studies are made independently in relation to subsistence alone: variation in robusticity and variation in directional bilateral asymmetry.

General patterns:

Univariate ANOVAs and ANCOVAs are employed to test the relationship of morphology to subsistence groups. This is preferred because of the nominative nature of the subsistence category data. Methods applicable to continuous data cannot be applied to these data.

Combining all time periods and regions, results from a one-way ANOVA comparing

sample means of all derived morphologies (except robusticity and asymmetry) to subsistence categories, by sex, are presented in Table 6.33.1. Sample means were chosen over individual data as central tendencies, and not individual variation, are the concern of this initial set of comparisons. Homogeneous subsets (groups of samples that significantly differ from each other), constructed from Games-Howell post-hoc test results, follow in Table 6.33.2. On this broad scale, it is evident that the relative lengths of the limbs to the torso, and the limbs to each other, have no significant variation among the subsistence groups. Other morphological traits do show a significant relationship to subsistence. Reviewing the homogeneous subsets (Table 6.33.2) indicates a pattern to this morphological variation. Specifically, crania among agriculturalists and village horticulturalists/hunters (VHH) tend to be rounder than the other groups, though this is likely an artifact of temporal variation among these groups. As demonstrated in the previous section, cranial index shows a general trend toward brachycephaly over time in the Americas. It should be noted that the agriculturalist and VHH samples date from the last 2500 years, whereas the three hunter-gatherer groups date to all time periods. Of greater note is the tendency for the VHH samples to be taller (both in total stature and in its postcranial components), more massive, and have higher intralimb indices. This group, as well, has a tendency to have narrower faces and noses. As all of the samples belonging to the VHH group lived on the Great Plains (Figure 6.3), and were potentially recent migrants there, however, this may be reflecting population history as well as subsistence. Such regional biases affect other possible distinctions. For example, marine hunter-gatherers (MHG) are generally absolutely shorter, wider-bodied and heavier than the freshwater hunter-gatherers (FHG), as well as lower in their intralimb indices. Yet, this might be an aberrant result as many of the MHG samples are found in the arctic and Pacific

Table 6.33.1. Results of one-way ANOVAs comparing derived morphologies to subsistence categories, across all time periods and regions, by sex. Strictly significant ($p < 0.01$) results are designated with an “X”, $p < 0.05$ results are shown by an “x”, and non-significant results left blank.

Sex	Morphology ¹														
	CRI	CRM	FI	NI	UBW	BI	CI	ATH	LLL	RTH	ULTH	ILI	BIB	BM	ST
Males	x	X	x	X	X	x	X	X	X				x	X	X
Females	X		x	X	x	X	X	x	x				x	X	x

¹ **Abbreviations:** CRI, cranial index; CRM, cranial module; FI, facial index; NI, nasal index; UBW, upper body width; BI, brachial index; CI, crural index; ATH, absolute torso height; LLL, lower limb length; RTH, relative torso height; ULTH, upper limb length/torso height; ILI, interlimb index; BIB, bi-iliac breadth; BM, body mass; ST, stature

Table 6.33.2. Homogeneous subsets for morphologies that significantly differ among subsistence groups, constructed from Games-Howell post-hoc tests. Subsistence categories are listed by their abbreviations (see Table 4.9 on page 198) in increasing order (from top to bottom) in relation to the mean value of the morphology for that category. Subsistence categories not significantly different from each other in each morphology (i.e., that form a homogeneous subset) are highlighted in the same shade of grey. Multiple shades of grey indicate more than two subsets.

	Dimension and subsistence category ¹ homogeneous subsets													
	CRI	CRM	FI	NI	UBW	BI	CI	ATH	LLL	BIB	BM	ST		
MALES	BSHG	AGR	BSHG	VHH	MHG	MHG	MHG	MHG	MHG	FHG	AGR	AGR	MHG	
	MHG	VHH	VHH	MHG	FHG	FHG	FHG	AGR	AGR	IH	FHG	FHG	AGR	
	FHG	BSHG	MHG	BSHG	BSHG	AGR	BSHG	FHG	FHG	AGR	IH	IH	IH	
	VHH	FHG	AGR	IH	AGR	IH	IH	BSHG	IH	BSHG	MHG	MHG	MHG	
	IH	MHG	IH	FHG	IH	BSHG	AGR	IH	VHH	MHG	BSHG	BSHG	BSHG	
	AGR	IH	FHG	AGR	VHH	VHH	VHH	VHH	BSHG	VHH	VHH	VHH	VHH	
FEMALES	CRI	CRM	FI	NI	UBW	BI	CI	ATH	LLL	BIB	BM	ST		
	BSHG	AGR	VHH	VHH	AGR	MHG	MHG	MHG	IH	AGR	FHG	MHG		
	MHG	VHH	MHG	MHG	MHG	IH	FHG	FHG	MHG	FHG	AGR	FHG		
	IH	BSHG	AGR	FHG	VHH	FHG	IH	AGR	AGR	IH	IH	AGR		
	FHG	FHG	BSHG	BSHG	IH	AGR	AGR	VHH	FHG	BSHG	MHG	MHG		
	VHH	MHG	FHG	AGR	FHG	BSHG	VHH	BSHG	VHH	MHG	BSHG	BSHG		
AGR	IH	IH	IH	BSHG	VHH	VHH	IH	BSHG	VHH	VHH	VHH			

¹ **Subsistence group abbreviations:** BSHG, broad-spectrum hunter-gatherer; MHG, marine hunter-gatherer; FHG, freshwater hunter-gatherer; IH, incipient horticulturalist; VHH, village horticulturalist/hunter; AGR, agriculturalist

Northwest. Both of these regions clearly introduce an extreme bias into examinations of morphological variation in the New World.

It has been established that at least some of these derived morphologies covary with climate and possibly with geography. Undoubtedly, some of the variation observed among the subsistence groups is the result of underlying variation in climate, as the two examples just cited (VHH and MHG) potentially exemplify. An ANCOVA bears this out, showing a significant interaction between subsistence and geography ($p < 0.01$), and subsistence and climate ($p < 0.01$). The results of the bivariate correlation of these factors reported in Table 6.3 also indicated this trend. Of course, just as in the climate analyses, the inclusion of arctic and Northwest Coast samples may be magnifying these relationships.

Thus, two additional analyses are conducted: general morphological variation in relation to subsistence without the high latitude samples, and the initial ANOVA using climate and geographic factors as covariates. Results of one-way ANOVAs excluding the high arctic samples, presented in Table 6.34.1, do demonstrate that these samples are influencing the relationships of subsistence to morphological variation. Among the males, cranial and facial indices, crural index, stature and bi-iliac breadth cease to significantly vary among subsistence groups. MHG samples still tend to have short absolute torso heights, low crural indices, high body masses and short statures, however. Most of these same patterns occur among subarctic females. In addition, subsistence groups continue to significantly vary among females in cranial indices, facial indices (mostly due to the relatively narrow faces of the VHH and AGR groups) and bi-iliac breadths (narrow AGR females versus wider-bodied MHG females). These results effectively erase the significant differences observed among the VHH samples and the remainder of the subsistence groups, though VHH males

Table 6.34.1. Results of one-way ANOVAs comparing derived morphologies to subsistence categories, across all time periods and **excluding high latitude samples**, by sex. Strictly significant ($p < 0.01$) results are designated with an “X”, $p < 0.05$ results are shown by an “x”, and non-significant results left blank.

Sex	Morphology														
	CRI	CRM	FI	NI	UBW	BI	CI	ATH	LLL	RTH	ULTH	ILI	BIB	BM	ST
Males		X		X	X	X		x						X	
Females	X	x	x	x									x	X	

Table 6.34.2. Results of one-way ANOVAs comparing derived morphologies to subsistence categories, **with climatic and geographic variables as covariates**, across all time periods and **all samples**, by sex. Strictly significant ($p < 0.01$) results are designated with an “X”, $p < 0.05$ results are shown by an “x”, and non-significant results left blank.

Sex	Morphology														
	CRI	CRM	FI	NI	UBW	BI	CI	ATH	LLL	RTH	ULTH	ILI	BIB	BM	ST
Males		x		x	X	X	x	X	x				X		X
Females	X	x				X	X	X						X	x

Table 6.34.3. Results of one-way ANOVAs comparing derived morphologies **among lower latitude samples** to subsistence categories, **with climatic and geographic variables as covariates**, across all time periods and by sex. Strictly significant ($p < 0.01$) results are designated with an “X”, $p < 0.05$ results are shown by an “x”, and non-significant results left blank.

Sex	Morphology														
	CRI	CRM	FI	NI	UBW	BI	CI	ATH	LLL	RTH	ULTH	ILI	BIB	BM	ST
Males								x						x	
Females	x													X	

¹ **Abbreviations:** CRI, cranial index; CRM, cranial module; FI, facial index; NI, nasal index; UBW, upper body width; BI, brachial index; CI, crural index; ATH, absolute torso height; LLL, lower limb length; RTH, relative torso height; ULTH, upper limb length/torso height; ILI, interlimb index; BIB, bi-iliac breadth; BM, body mass; ST, stature

and females continue to have absolutely longer torsos, lower limbs and statures.

Does taking climate and geography into account change the interpretation of these results? Using climate and geography as covariates, one-way ANOVAs among all samples (Table 6.34.2) indicate that significant differences among subsistence groups persist for many of the morphologies listed in Table 6.33.1. The exceptions are facial index in both sexes, cranial index and body mass among males, and nasal index, upper body breadth, lower limb length, and bi-iliac breadth among females. However, as the results of the ANOVA excluding high latitude samples indicate, inclusion of the arctic hunter-gatherers has a significant effect on these patterns. Lower latitude samples considered alone (Table 6.34.3), with climate and geography as covariates, indicate that morphology generally *does not* significantly vary among subsistence groups. Climate and subsistence are inexorably linked, much as climatic factors and geography. So, accounting for one as a covariate effectively removes the explanatory power of the other. Yet, the inclusion of the high latitude samples introduces more variation than can be accounted for simply by climate and geography (Table 6.34.2). Analyses of temporal and regional differences among morphologies in relation to subsistence may aid in explaining how these various environmental factors relate to morphology and to each other.

One final area of inquiry concerns sexual dimorphism in morphologies and their relationship with subsistence groups. These indices are tested on only five morphologies: intralimb indices, stature, body mass, and bi-iliac breadth. Mean sexual dimorphism indices combining all time periods are shown in Table 6.35. ANOVA comparisons show that strictly significant ($p < 0.01$) differences only exist in stature and body mass, with less restrictive significant differences ($p < 0.05$) among subsistence groups in brachial index sexual

Table 6.35. Mean sexual dimorphism¹ indices for subsistence groups for five derived morphologies, all times and regions. Significantly different sexual dimorphism ($p < 0.01$) among subsistence groups are denoted with an asterisk.

Subsistence	Dimension				
	Brachial index	Crural index	Stature	Body mass	Bi-iliac breadth
BSHG	1.083	0.635	7.690	18.155*	5.213*
FHG	1.284	0.807	7.229	16.676	2.407
MHG	2.087*	-0.003	5.719	16.632	3.086
IH	2.543*	0.566	5.601	14.452	3.164
VHH	1.220	0.733	8.964*	18.797*	6.804*
AGR	1.212	0.604	6.364	18.257*	3.511

¹ [(male mean – female mean) ÷ (mean of male and female measurements)] x 100.

dimorphism. Generally, males have greater body mass, stature, and body breadth (which is not surprising), and sexual dimorphism is higher in brachial index, mirroring previous results in this chapter that showed significant differences in this morphology between males and females. The most interesting result is the high sexual dimorphism among broad spectrum hunter-gatherers in body size (mass, stature and width), equaled only among VHH samples and, in body mass, agriculturalists. Note also that the sexual dimorphism among MHG groups in crural index appears lower than the other groups, but that, generally, crural index is not sexually dimorphic among any groups.

6.4.1: Within time periods across geography

The temporal range of the sample is divided into four groups for analyzing subsistence and morphological variation. From 8000 to 4000 yBP, the oldest time frame considered, samples represented in these analyses practiced various forms of non-horticultural subsistence, including highly sophisticated methods of fishing, marine and terrestrial hunting, and the exploitation of many wild and passively cultivated plants. (An advantage of this

aggregated temporal period is the lack of arctic and subarctic samples.) These subsistence patterns continue to be represented to the present, but were joined by organized horticulture samples throughout the Americas and early agriculture samples in South America between 4000 and 2500 yBP. Many groups in the southern and central latitudes of North America shifted to an agricultural subsistence pattern between 1500 and 1000 yBP, and so samples from this time period are examined separately. Finally, over the last millennium, only five subsistence groups are represented in the Americas, as broad-spectrum hunting and gathering was increasingly rare in this period, though village horticulturalists are represented by a substantial sample from the Great Plains.

Before horticulture – 8000-4000 yBP:

After excluding early Holocene skeletons (who were broad-spectrum hunter-gatherers), the remaining samples from this period represent freshwater and marine hunter-gatherers. Analyses are therefore restricted to these latter subsistence groups. Only three morphologies significantly ($p < 0.01$) differ between these groups, all of which reflect body size: cranial module, body mass, and bi-iliac breadth. MHG males and females had significantly larger crania, and wider and more massive bodies.

Looking back at the geographic distribution of these two subsistence groups, however, confounds what at first appears to be a simple dichotomy. The MHG samples lived along the Californian coast, while the FHG samples lived in northern Florida and the Tennessee (and Green, an extension) River Valley. So, it is equally possible that the differences observed are the result of geography and population history. Climate analyses also encountered this geographic conundrum. Taking climate variables into account as covariates, only bi-iliac breadth remains significantly different between marine and freshwater hunter-gatherers

(marine greater), and only in males ($F = 16.042$, $p < 0.01$; female $F = 0.137$, $p = 0.712$).

Analyses of more subsistence groups in later time periods will reveal if this difference persists, or if it is a consequence of sampling.

4000-1500 yBP:

Horticulture (in a broad sense) appears in samples from central California and along the Illinois and Mississippi River Valleys during this temporal period, and marine hunter-gatherers continued to be represented in southern California and northern Florida⁹, while freshwater hunter-gatherers continue to be represented in the Tennessee River Valley, as well as along the Great Lakes and Northern California. Marine hunter-gatherer samples are also presented from the Pacific Northwest and the Western Arctic, and three samples from South America also introduce agriculture into this time period, but as geography and climate make these samples exceptional, they are initially examined but then excluded in analyses.

Results for comparisons of morphologies to subsistence, without and with climate variables taken into account as covariates, are presented in Table 6.36. As in the general comparison of subsistence groups, males show more variation among subsistence groups. Note that the comparisons reported in Table 6.36 are made including the high latitude and South American samples. With the omission of the high latitude and South American samples, cranial module, upper body width (in males), absolute torso height, stature and bi-iliac breadth (also only in males) differ significantly among groups. Omitting these regions and taking climate and geography into account, only stature and absolute torso height remain significantly different among subsistence groups.

⁹ Note that these MHG groups engaged in different behaviors. The Channel Island groups in California both gathered marine shellfish and actively hunted marine mammals, while the Floridian groups were less active hunters, relying more on fishing.

Table 6.36. Results of one-way ANOVAs comparing derived morphologies to subsistence categories, between 4000 and 1500 yBP, by sex. The first set of results compares only subsistence with morphology; the second include climate variables as covariates. Strictly significant ($p < 0.01$) results are a bold, upper-case “X”, $p < 0.05$ results are denoted with an “x”, and non-significant results left blank. Abbreviations for morphologies are the same as those used in Table 6.33.

Analysis	Sex	Morphology											
		CRI	CRM	NI	UBW	BI	CI	ATH	LLL	ILI	BIB	BM	ST
Subsistence alone	♂	X	X	X	X	x	X	X	X	X	x	x	X
	♀	X	X	X		X	X	X	X			X	X
Climate variables as covariates	♂		X		X			X	x		X		x
	♀							X	X				X

Comparisons of means of the different morphologies significant after taking climate into account clarify the relative variation among the subsistence groups. BSHG and AGR males both have smaller crania than the three other subsistence groups (with the MHG and IH males possessing the largest crania). Similarly, the BSHG and AGR groups are narrower (as are the FHG) than the horticulturalists and marine hunter-gatherers, in bi-iliac breadths, though only the IH males are significantly wider in the upper body. In both sexes, marine hunter-gatherers remain the shortest (both in total stature and component dimensions), but only slightly less than South American agriculturalists. This trend remains significant with the South Americans and high latitude samples' exclusion, as the FHG and IH groups remain taller, on average, by five centimeters and eight centimeters, respectively (there is little difference between the sexes in the differences among groups). Interestingly, sexual dimorphism in stature, body mass, or bi-iliac breadth does not differ among these groups.

Transition to agriculture – 1500-1000 yBP:

Group comparisons during this time period include only four of the subsistence

Table 6.37. Results of one-way ANOVAs comparing derived morphologies to subsistence categories, between 1500 and 1000 yBP, by sex. The first set of results compares only subsistence with morphology; the second include climate variables as covariates. Strictly significant ($p < 0.01$) results are a bold, upper-case “**X**”, $p < 0.05$ results are denoted with an “x”, and non-significant results left blank.

Analysis	Sex	Morphology											
		CRI	CRM	NI	UBW	BI	CI	ATH	LLL	ILI	BIB	BM	ST
Subsistence alone	♂	x	X	x	x		x		x				X
	♀	x	x	x	x	x	x	x	X		x		X
Climate variables as covariates	♂		x										x
	♀		x						x				x

categories; VHH (though one site—Huffmann—in the EOD is considered VHH, it consists of only two individuals and is excluded for statistical reasons) and MHG are not represented. Comparing morphologies among all of these groups without accounting for climate (Table 6.37), all morphologies except facial index, interlimb index, and body mass significantly ($p < 0.05$) differ among females. Bi-iliac breadth, brachial index, and absolute torso height are, in addition to the other morphologies, not significantly different among males. However, accounting for climatic factors as covariates, only cranial module and stature significantly differ among groups for both sexes. Lower limb length also differs among females.

Differences among groups in these morphologies follow a pattern similar to the previous temporal period. Mean statures for both male and female BSHG and IH samples are higher than FHG, and considerably (more than 10 cm) taller than agriculturalists. This may be an effect of geography, much as in the case of the 8000 to 4000 yBP time period; the agriculturalist samples are from Peru, Guatemala, and southern Utah. Given the geographic range among the agriculturalists, however, these results likely reflect a difference associated with subsistence. Cranial module and lower limb lengths are also lowest among

agriculturalists for both sexes. Perhaps the latter pattern is the most compelling evidence that the lower statures among the agriculturalists is an effect of subsistence. Lower limb length in climatic analyses generally covaries with the mean highest temperature of the warmest month, yet all locations sampled for agriculture were warm (though climate data for Petén are not available), and certainly warmer than the locations occupied by some of the other subsistence groups. Again, it is notable that sexual dimorphism in these morphologies is not significantly different among the subsistence groups.

1000-100 yBP:

This aggregated time period constitutes the largest total sample (1892 skeletons in the POD and EOD combined) of any time, and includes samples from all subsistence groups, though the BSHG is limited to a single individual. Therefore, this subsistence group is excluded from analyses. It must be noted, as well, that the majority of the MHG and FHG samples from this time period come from arctic or subarctic regions.¹⁰

Significant differences among subsistence groups were compared by one-way ANOVAs utilizing sample means. Results are shown in Table 6.38, along with ANOVA results in which climate is a covariate. Of the morphologies previously cited as significantly differing among groups, only absolute torso height, stature and bi-iliac breadth significantly differ among subsistence groups in the most recent time period, once climate is taken into account as a covariate. Surprisingly, intralimb indices demonstrate significant differences as well, but this is a result of the high latitude bias in the hunter-gatherer samples. Omitting high latitude samples from the arctic and Tierra del Fuego, intralimb indices do not significantly

¹⁰ The only hunter-gatherer samples not from the arctic, Pacific Northwest or Tierra del Fuego are the Yuma (who were a mix of agriculture and freshwater hunter-gatherers), the Caplen and Mitchell sites on the coast of Texas, and the Toba from Gran Chaco. These hunter-gatherers certainly cultivated relationships with their farming neighbors, while most everyone else jumped on the agricultural bandwagon.

Table 6.38. Results of one-way ANOVAs comparing derived morphologies to subsistence categories in samples dating to the last millennium, by sex. The first set of results compares only subsistence with morphology; the second include climate variables as covariates. Strictly significant ($p < 0.01$) results are a bold, upper-case “**X**”, $p < 0.05$ results are denoted with an “x”, and non-significant results left blank. Intralimb indices are shown in italics for the second set of results, as these are a biased result of including high latitude samples.

Analysis	Sex	Derived morphology									
		FI	NI	UBW	BI	CI	ATH	LLL	BIB	BM	ST
Subsistence alone	♂		X	X	X	X	X	X	X	X	X
	♀	x	X		X	X		X	x	X	
Climate variables as covariates	♂			x	x	x	X		X	x	X
	♀	x			x	x				x	

differ among subsistence groups. The other morphologies, however, remain significantly different among subsistence groups. Nonetheless, the inability of climatic factors to account for the variation observed in intralimb indices is perplexing, as climate and geography analyses of this time period showed that, when high latitude samples are included, both intralimb indices strongly covary with climatic factors. In general, it is noteworthy that males demonstrate more variation in these morphologies than females, especially when climatic factors are taken into account as covariates.

An examination of means for significantly different morphologies among subsistence groups, after accounting for climatic factors, implicates the village horticulturalist/hunters as much of the source of the variation observed. Of the morphologies significantly varying among the males, the values are highest for these inhabitants of the Great Plains; male VHH samples were significantly broader (both upper body and bi-iliac breadth), taller, and more massive than any other subsistence group’s males. These trends also exist among the females, though only reach statistical significance in body mass. In fact, female statures, on average, vary by only 5 cm when including arctic samples, and by only 2.4 cm when

excluding the high latitude samples. Contrastingly, males differ by 11 cm in mean stature among subsistence groups when including high latitude samples, and by 8 cm without them. This is further shown to be of importance by comparisons of sexual dimorphism; subsistence groups differ in stature sexual dimorphism, where VHH sexual dimorphism is significantly greater than the other groups, and IH sexual dimorphism in the same morphology is significantly lower. None of the other sexual dimorphism indices significantly differ among the groups. Interestingly, the VHH females had significantly narrower faces than other groups, while IH females were relatively very broad-faced. This is the only time a significant difference in this morphology has been clearly shown in any comparison.

A question emerges from these results: are the observed morphological differences the result of the mode of subsistence chosen by these groups, or are they merely reflections of population history and, possibly, prior adaptations to environmental factors? Perhaps much of the significance in the VHH results is a simple matter of sample bias. The only samples to present more than limb data (i.e., the POD samples) are those associated with the Arikara, who were likely later arrivals¹¹ on the Great Plains, and into South Dakota (Zimmerman, 1985). Yet, a comparison of lower limb lengths and intralimb indices shows no significant difference among all of the samples available from the Great Plains during this time period; lower limb lengths are all high (>80 cm), and brachial and crural indices are likewise on the higher end of the total distribution. These were all, compared with all of the other groups

¹¹ The earliest horticulture on the Great Plains dates to circa 2000 yBP (Fagan, 2002), and may have emerged from Hopewellian culture which bordered the Plains to the east, along the Mississippi River Valley. The Caddoan-speaking groups living in the majority of the Central Plains, and so making up the majority of the Plains sample, have unquestionable ties to the Caddo of the lower Mississippi River Valley (and who are represented in this sample as well) based on culture (especially religious symbolism) and historical records. As discussed in Chapter 2, it is likely that these Caddoan speakers migrated into the Central Plains after the establishment of horticulture and village-based lifestyles a millennium before, though the relationships of Central Plains culture groups are still unresolved (Key, 1994; Wescott, 2001). See Chapter 2 (Traditions of North America section) and the Discussion chapter for further consideration of these topics.

observed in North America, relative “giants,” in their higher masses, greater body widths, and, among males, considerably greater statures. Whether their large size was a result of population history (the Caddo groups to the southeast were equally tall, and are one potential origin for the peoples living farther north and west in the Great Plains), their mode of subsistence, their climate, or a combination of these cannot be resolved by the current data.

Additional points concerning comparisons from this last aggregated time period are:

- Males have more morphological variability than females in the most recent time periods (and, to a lesser extent, earlier time periods) among subsistence groups. This is especially noticeable in stature (and its component dimensions), body mass, and bi-iliac breadth.
- Agriculturalists are the least massive and the narrowest-bodied of the groups, yet are second only to the VHH males in stature for both sexes.
- Even with the omission of high latitude samples, the marine and freshwater hunter-gatherers have the lowest brachial, crural and interlimb indices. Contrastingly, VHH and AGR groups have the highest indices. VHH groups have the lowest relative torso heights (though this is not statistically significantly different) among males and second lowest among females.
- Also, though not significantly different, VHH males and females have lower nasal indices than any other group, including the MHG and FHG groups.
- VHH males and females have mean bi-iliac breadths greater than the next-closest group—marine hunter-gatherers—by more than a centimeter. For context, the range of difference for all of the other subsistence groups from the last millennium in bi-iliac breadth is half that amount.

6.4.2: Within regions (across time periods where applicable)

As in climatic analyses, regional considerations are used to examine differences in morphologies through time, while limiting geographic range and therefore, potentially, effects of population history (or detect changes associated with population history). This is especially useful in the Southeastern U.S. and the Prairie and Eastern Woodlands, where hunting and gathering were replaced by horticulture and agriculture, in some cases in nearly identical geographic locations (e.g., the Tennessee River Valley). Note that some regions have had little variation in subsistence practices, and so have been combined with neighboring regions (the same as in climate analyses) where different modes of subsistence were practiced. As all of the samples from the U.S. Southwest represent agriculturalists (granted, various forms of agriculture), this region is not examined (as sample comparisons in morphology were already made under the climate regional analysis). Additionally, South America is not considered in this subsection, because the only samples from the POD were agriculturalists, and many of the morphologies that have been indicated to vary among subsistence groups cannot be adequately compared with the inclusion of the EOD samples. Furthermore, given the great geographic distances among the subsistence groups, disentangling population history, geography, climate and subsistence (as implied by the comparisons made among morphologies in relation to climate in South America) would be difficult.

The Arctic:

Two subsistence groups are represented in the arctic: the marine and freshwater hunter-gatherers. The former constitutes samples from the Aleutians, the northwestern coast of Alaska, and the greater Hudson Bay area. In contrast, the latter is present among samples

from the Lower Yukon and Kuskokwim River Valleys. It should be pointed out that the dichotomy between these subsistence groups in the arctic is not distinct. Marine hunter-gatherers were known to have exploited inland flora and fauna (such as moose) in addition to their hunting of marine mammals and fishing. Freshwater hunter-gatherers, as well, consumed some marine shellfish, though their diet was predominantly composed of inland resources and, seasonally, salmon.

One-way ANOVA comparisons made between these subsistence groups, combining all time periods and only examining the last millennium (the time period to which the FHG samples date), yield similar results for both sexes. Significant differences between the subsistence groups occur in cranial module, nasal index, upper body width, interlimb index, body mass, and bi-iliac breadth. Accounting for climate variables as covariates (given the range mentioned previously), only upper body width, interlimb index and bi-iliac breadth differ significantly. Removal of the more temperate and wetter climate Aleutian Island samples does not change these results. Generally, FHG samples have smaller crania, higher nasal indices, wider upper bodies, longer upper limbs relative to lower limbs, lower body masses, and narrower bi-iliac breadths than the MHG samples. An examination of only Western Arctic groups retains these patterns except the significant difference in body mass; inclusion of the massive Sadlermiut bias this result (though accounting for climate also removes it from significance). In all comparisons, sexual dimorphism in morphologies does not significantly differ between the MHG and FHG samples.

These results, however, should not imply homogeneity among the marine hunter-gatherers. For example, in comparison with other MHG samples, Aleut samples have significantly higher ($p < 0.01$) nasal indices, higher brachial indices, longer torsos (and

relatively shorter upper limbs), and, between the Pre-Aleut and other groups, wider bi-iliac breadths. This latter difference, though subtle, may be related to adaptation among the Alutiiq after colonizing the Aleutian Islands from colder regions to the east in the Alaskan mainland.

The Pacific Northwest and the Western Plateau:

Like the arctic, two hunter-gatherer groups are present in these regions' samples: FHG and MHG. As observed among the more northern groups, marine hunter-gatherers, after a one-way ANOVA, have larger crania, lower nasal indices, higher body masses, and wider bi-iliac breadths (the latter two in males only). Unlike the arctic samples, however, the marine hunter-gatherers in the Pacific Northwest have *wider* upper bodies, in addition to significantly ($p < 0.01$) longer absolute torso heights (10 cm for males, 15 cm for females), though their statures do not differ significantly. Accounting for climate variables, all of these differences cease to differ significantly between these subsistence groups. Sexual dimorphism in morphologies does not significantly differ among groups.

Similarly, if only samples from the last millennium are examined (the time periods to which the FHG samples date), none of these morphologies significantly differ between subsistence groups. This last finding is not surprising, however, given the tendency (as shown in the regional climate analyses) for the Kwakiutl (MHG) to group with the Coast Salish (FHG). Indeed, the significant differences observed when combining all time periods from these regions clearly demonstrate a temporal distinction, and not a subsistence-based one. MHG male samples from Prince Rupert Harbor, for instance, were heavier, had wider bi-iliac breadths, had wider upper bodies, and longer torsos than the marine hunter-gatherer from the last 1000 years.

The Great Plains and South Texas:

The Great Plains, as discussed in the temporal analyses of morphological variation in relation to subsistence, present a sample that is almost entirely made up of the village horticulturalist/hunter subsistence group. Combined with South Texas samples, other subsistence groups are represented—Ernest White, Loeve Fox, and the Huffman sites represent BSHG, and Caplen and Mitchell are representative of a mixture of freshwater and marine hunter-gathering. As pointed out previously, many samples in the Great Plains (including Huffman) are from the EOD, providing morphological data in these samples from limb dimensions only. Limb morphologies and body mass are, therefore, the only variables to include these EOD samples.

Combining time periods (in order to include the older BSHG sites in the comparison), significant ($p < 0.01$) differences are shown, by one-way ANOVAs, to exist in cranial index, nasal index, body mass, relative torso height, and bi-iliac breadth, though not among females for the last two (lower limb length, however, does additionally differ among females). Interestingly, as found in the other regions thus far, there are no significant differences in stature among these subsistence groups. Taking climatic factors into account as covariates, though, none of these morphologies remains significantly different, nor do their indices of sexual dimorphism differ among subsistence group samples.

Among subsistence groups, patterns of morphological variation are similar for males and females. Cranial index is significantly lower for the temporally earlier BSHG groups, though this may reflect the trend for more dolichocephalism in earlier samples, as demonstrated earlier in this chapter. Nasal indices are significantly lower for the VHH samples, which also have shorter lower limb lengths. As a consequence of the latter, males have higher relative

torso heights, and also have lower relative upper limb to torso height lengths. These together imply longer limbs in the hunter-gatherer groups, especially among the males. Finally, body masses were higher in the VHH samples than the hunter-gatherers, despite no significant differences in stature or, in the case of females, bi-iliac breadth. This is interesting, as in the general patterns of variation among combined samples across the continent, VHH males have significantly greater statures than most other groups (see Table 6.33.2).

Controlling for climate, none of these differences are related to subsistence; the VHH samples lived in generally drier and more extreme seasonal temperatures than the hunter-gatherers compared here. Thus, like the climate comparisons made using these regions, the relationship of differences in morphology to environmental factors is ambiguous—geography, climate and subsistence were all different among these groups. Yet, the lack of significant results after controlling for climate variables would imply that these subsistence practices were tied inexorably to climate (a pattern noted before), and therefore morphologies could have varied as a result of a combination of these environmental factors.

The Prairie and Eastern Woodlands:

Subsistence modes hardly ever overlapped within time periods in the Prairie and Eastern Woodlands. The earliest sample—Modoc Rock Shelter, from 4000–2500 yBP—is one of two representatives of FHG, and did not coincide temporally with any other samples. Over the subsequent 1500 years, all samples represent horticulturalists. Agriculturalists appear in and predominantly represent the sample from the last millennium, with one sample—Donaldson (the other FHG site)—that is not agricultural. Therefore, differences found among subsistence groups in this region could be equally attributable to temporal change, population history, or subsistence.

Nevertheless, comparisons of morphologies among the subsistence groups from this region indicate that morphological variation was minimal; differences reaching less restrictive significance ($p < 0.05$) are facial index in both sexes, relative torso height among females, and lower limb length and stature significantly among males. Adding climate variables as covariates eliminates significant differences for any morphology. Facial indices, in the case of both sexes, are significantly higher for the FHG group, which echoes the morphological difference of individuals from the Modoc Rock Shelter from the other, temporally later subsistence groups. The difference in male lower limb length and in stature is also a differentiation between the FHG group from the IH and AGR groups, where the latter two are shorter than the males from Modoc Rock Shelter and the Donaldson site. Relative torso height among females reveals the same pattern: FHG females had relatively shorter torsos, which, conversely, implies that they had longer lower limbs (which is borne out by comparisons of mean values of the three groups). Reinforcing the parallel nature of the differences in both sexes, sexual dimorphism indices do not significantly differ among these subsistence groups. Overall, then, different subsistence groups in the Prairie and the Eastern Woodlands were, on average, similar to each other.

Subsistence groups were not homogeneous, however. Among both male and female incipient horticulturalist samples, a significant difference ($p < 0.05$ after an ANOVA) is found in brachial indices (skeletons from the Albany site in Illinois, on average, had lower brachial indices than the other IH samples). In addition, Libben males had significantly longer limbs than the other samples. Agriculturalist males and females significantly differ in cranial index, relative torso height, and relative upper limb length/torso height, with bi-iliac breadth additionally differing significantly among males. The distinction in cranial index is

between the inhabitants of the northeastern coast and the late Mississippian sample from Madisonville (in the Ohio River Valley). For females, this is also the distinction in relative torso height (with Maine, Cape Cod and Montague samples' torsos significantly shorter), though among males, the pattern is the same with the exception of high relative torso heights in the Maine sample. Among males, agriculturalists living further inland had wider bi-iliac breadths and higher body masses as well.

It is possible that these myriad differences in lower limb lengths and torso heights, as well as body masses, are related to subtle differences in subsistence modes, population densities, population history, or microclimates. It is notable that these variations are not observed among subsistence groups, which further implies that morphological variation within subsistence groups in this region was greater than the variation among groups. A comparison of subsistence groups in the Southeastern U.S. may help clarify this pattern.

The Southeastern U.S.:

Until 1500 yBP, all of the samples in the Southeastern U.S. belonged to either the MHG or FHG groups; marine hunter-gatherers are present during the 2500–1500 yBP time period while freshwater hunter-gatherers are represented from 8000 yBP (by Windover) until 2500 yBP. Agriculturalists and horticulturalists are represented after 1500 yBP, though there are no hunter-gatherer samples present during those periods. Thus, two sets of analyses are undertaken for the Southeastern U.S.: a comparison combining all time periods, and comparisons of variation among subsistence groups before and after 1500 yBP.

The results from one-way ANOVAs comparing these temporal periods are presented in Table 6.39. Given the broad temporal range, it is not surprising to observe significant differences in male intralimb indices in the combined temporal sample. The source of the

Table 6.39. Results of one-way ANOVAs comparing derived morphologies to subsistence categories in Southeastern samples. These results report comparisons of only subsistence with morphology, without taking climate into account as a covariate. Strictly significant ($p < 0.01$) results are a bold, upper-case “X”, $p < 0.05$ results are denoted with an “x”, and non-significant results left blank.

Analysis	Sex	Morphology ¹								
		UBW	BI	CI	ATH	LLL	RTH	BIB	BM	ST
All time periods	♂	X	X	x	X	x	x	X	X	X
	♀	X			X	X		X	X	X
8000–1500 yBP (hunter-gatherers)	♂		X							
	♀							X	X	X
1500–100 yBP (horticulture & agriculture)	♂					x			X	
	♀					x		x		

¹ UBW, upper body width; BI, brachial index; CI, crural index; ATH, absolute torso height; LLL, lower limb length; RTH, relative torso height; BIB, bi-iliac breadth; BM, body mass; ST, stature

difference is in keeping with patterns observed in the general comparisons—significantly low intralimb indices among marine hunter-gatherers, which are only sampled from the western Floridian coast in this region. These samples (Palmer and Bayshore) also are significantly shorter in absolute torso height and in lower limb length among males, but not females (wherein the FHG samples have shorter limb lengths and torso heights). Additionally, MHG female samples have considerably higher masses and wider bi-iliac breadths than the other groups (a trend that is repeated among females when only hunter-gatherers are examined), though the male agriculturalists (or, arguably, VHH) from Arkansas and Louisiana had higher body masses and bi-iliac breadths. In fact, these latter agriculturalists also had significantly longer lower limbs, though their statures are not significantly different from the other agriculturalist or the horticulturalist groups; as a whole, these groups are taller than the hunter-gatherers. It is also noteworthy that indices of sexual dimorphism in body mass *do* significantly vary among these subsistence groups; MHG samples have less sexual

dimorphism in mass than the other groups. Just as in all other regions, taking climate into consideration as a covariate in ANOVAs reduces the *p*-values of all of the morphological differences among subsistence groups to non-significance.

The diversity in subsistence groups among Southeastern U.S. samples allows further examination of hypotheses made about the relationships of subsistence to morphology.

Table 6.40 presents the means and standard deviations of four morphologies hypothesized to vary in relation to subsistence (absolute torso height, lower limb length, stature, and body mass), and one that is not (bi-iliac breadth). In order to exemplify differences, horticulturalists have been excluded from this table. The higher variance (as implied by comparing standard deviations) for FHG and AGR samples in absolute torso height, lower limb length, and stature are attributable to the larger number of samples (and therefore, more variability) that make up these groups. Note that all of these morphologies significantly vary among subsistence groups in both sexes.

Table 6.40. Means and standard deviations for select derived morphologies among Southeastern U.S. samples, by subsistence and by sex, all time periods combined (excluding the Windover sample). Note that the agriculturalists from Louisiana and Arkansas (Caddoan-speaking samples) are presented separately in this table due to their unique location bordering the Great Plains and Southeastern U.S. Highest values are **bolded**.

Sex	Subsistence group	Absolute torso height (cm)		Lower limb length (cm)		Stature (cm)		Bi-iliac breadth (cm)		Body mass (kg)	
		Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Males	MHG	36.91	.76	80.13	3.58	161.87	4.84	26.75	1.41	64.79	4.25
	FHG	37.43	1.99	80.06	4.27	162.07	5.99	25.97	1.24	61.88	5.28
	Caddo AGR	38.54	1.16	83.23	3.82	166.73	3.88	27.89	1.85	68.95	5.72
	AGR	38.95	1.62	81.08	3.69	167.56	6.33	27.27	1.43	65.89	5.92
Females	MHG	35.82	1.09	76.50	2.76	156.19	2.26	27.11	1.45	57.41	3.28
	FHG	35.12	1.69	74.12	3.51	151.78	6.31	25.23	1.13	51.64	4.22
	Caddo AGR	36.74	1.50	77.66	2.83	158.74	2.31	26.82	1.07	57.07	5.12
	AGR	36.55	1.59	75.63	3.56	157.48	5.06	26.09	1.45	54.57	5.08

The general pattern that emerges from this table is that agriculturalists were as tall, or taller, than hunter-gatherer groups living in the same region, as well as equally or more massive. This does not support the hypothesis that, after the advent of agriculture, these morphologies would significantly *decrease*. A higher bi-iliac breadth among AGR males is interesting as well, as this morphology was hypothesized to covary with climate alone. Admittedly, the agriculturalist groups lived in a cooler overall climate than the hunter-gatherers (see Figure 6.1), the difference (though significant) is small, and females do not fit this pattern. Whether these differences were the result of population history, climate, subsistence, or a combination of these factors, it *is* clear from these results that the adoption of new subsistence strategies are not associated with decreases in stature or body mass in either males or females. One final point worth considering is that these populations in the Southeastern U.S. did not engage in the type of intensive agriculture found in state-level societies, like those in Mesoamerica and South America, where shorter statures and body masses that have been potentially associated with diet and stress have been documented (e.g., Bogin and Keep, 1999; Danforth, 1999).

The Great Basin and California:

These regions are interesting because, among their samples, there is representation of FHG, MHG and IH groups, but no agriculturalists.¹² As stated in the regional climate analysis, these regions have a temporal depth nearly equaling the Southeastern U.S., but unlike that region, subsistence groups overlap temporally; hunter-gatherers and horticulturalists exist at the same time. For this reason, two temporal analyses are undertaken for these regions: all time periods combined, and from 4000–1000 yBP, which includes

¹² Broad-spectrum hunter-gatherers also are represented in samples from the Great Basin, but these do not constitute a single sample, and rather are burials of fewer than five individuals (many are isolated).

samples from all three represented subsistence groups.

An ANOVA comparing morphologies with all time periods combined reveals different patterns for males and females. Males significantly ($p < 0.01$) differ in cranial index, cranial module, upper body width, absolute torso height. In all cases except cranial module, horticulturalists have significantly higher values for these morphologies; cranial module is significantly smaller for FHG males. In contrast females do not differ in cranial index or upper body width, but do in cranial module, absolute and relative torso height, relative upper limb length/torso height, stature, and body mass, though only absolute torso height and stature significantly differ at $p < 0.01$. In all of these morphologies except cranial index and relative upper limb length/torso height, IH females have higher values. In cranial index, both IH and FHG females have significantly rounder crania than MHG females, and IH females have significantly shorter upper limbs relative to torso height. The higher cranial indices may be functionally related to softer diets or less mandibular stress in horticulturalists, and taller statures would be expected in populations with better nutrition. Body mass may also be higher in samples with better overall nutrition or reduced stress. Considering climatic factors as covariates, however, there is no statistical significance among these relationships.

When considering only samples from 4000 to 1000 yBP, subsistence groups differ in almost the same morphologies for both sexes. Cranial index, cranial module, upper body width, absolute torso height, lower limb length, stature and body mass all significantly ($p < 0.05$) differ for both sexes; only bi-iliac breadth significantly differs, additionally, for males. In all of these morphologies, IH males and females have the highest values, except for female cranial index, wherein, again, both FHG and IH females have significantly higher cranial indices than MHG females. Thus, in a more constrained temporal period, many of the

patterns are the same as those in the total sample combining all time periods, and sexual differences, on the whole, do not exist. Sexual dimorphism indices, it should be added, do not significantly differ among these subsistence groups.

These results imply that, including marine hunter-gatherers from the Channel Islands and the coast of southern California, as well as freshwater hunter-gatherers and horticulturalists from throughout the region, horticulturalists were generally taller, broader, more massive, had larger and rounder crania, and generally had longer limbs than their hunter-gatherer neighbors. The behavioral distinction between these groups is, admittedly, subtle: the IH groups were more sedentary and harvested acorns more intensely than the FHG group. The latter also exploited freshwater shellfish more often than the IH groups, who relied on hunting game instead. It is possible that additional protein and calories from these sources (wild game, acorns, or other food sources), as well as different population histories, contributed to the differences among these subsistence groups.

A final comment on morphological variation and subsistence:

Before proceeding to examine two specific sets of morphological variation (robusticity and asymmetry) with subsistence, it is beneficial to summarize the results of these temporal and regional analyses. It is evident that morphologies do differ among groups practicing different forms of subsistence, but these are not the same across all regions or time periods. Stature and body mass (or cranial module, another morphology reflecting size) do significantly differ. The biological significance of these differences is uncertain, given the small differences that exist among some subsistence groups. For example, in the Southeastern U.S., subsistence groups vary by less than ten centimeters in mean stature. There is a general trend for horticulturalists and agriculturalists to be taller than hunter-

gatherers, however, with the exception of broad-spectrum hunter-gatherers, who are equally as tall. Body mass differences, on the whole, are equivocal and sample-specific.

Additionally, female samples are equally as variable as males among subsistence groups in these morphologies, though males tend to vary more in bi-iliac breadth. Worth noting, as well, is the general lack of variation among subsistence groups in intralimb indices, relative torso height (even though its components widely vary), nasal index, and, generally, facial index. Controlling for climatic factors, both continentally and within regions, often mutes the significance of these differences, indicating either that the morphological variation is better explained by climatic factors (even though climate analyses were unclear in many of these instances), or that climate and subsistence are too closely linked for statistical power to remain when climate is included as a covariate. Indeed, it may be argued that a combination of climate and subsistence effects influence this morphological variation. This will be considered at greater length in the Discussion.

6.4.3: Robusticity

Up to this point in the analyses, it has been necessary to take multiple environmental factors into account in examinations of morphological diversity. In considering the robusticity of the humeral and femoral diaphyses, however, subsistence alone is considered, as robusticity is regarded as a reflection of biomechanical loading and, to some extent, diet and stress (see subsection 4.3.4). These two limb bones are chosen for analysis because they most clearly represent the activity of the upper and lower limbs.

Table 6.41 presents the mean values for robusticity in each of the dimensions considered from the humeral and femoral diaphyses by subsistence group.¹³ All robusticity

¹³ Average humeral and femoral diaphyseal robusticities for each sample are reported in Appendix V.

Table 6.41. Mean robusticity values for humeral and femoral diaphyseal dimensions, by sex and subsistence group. Underlined values denote a dimension (or group of dimensions) that is significantly ($p < 0.05$) different from the all other groups' values in that dimension (assessed in one-way ANOVAs by sex); an asterisk represents values that are significantly different among the underlined values. Note that the last column is the ratio of humeral average diaphyseal robusticity to femoral diaphyseal robusticity.

Sex	Group	Humeral diaphysis (50%)			Femoral diaphysis (50%)			Humerus / femur average diameter
		Medio-lateral diameter	Antero-posterior diameter	Average diameter	Medio-lateral diameter	Antero-posterior diameter	Average diameter	
MALES	BSHG	433.01	420.22	425.32	643.46	851.40	735.63	57.82
	FHG	456.94	421.78	437.46	591.25	815.48	694.01	63.03
	MHG	<u>591.16</u>	<u>523.75</u>	<u>554.27</u>	<u>691.66</u>	<u>905.69*</u>	<u>790.59</u>	70.11
	IH	446.25	421.75	432.08	611.13	<u>806.77</u>	701.00	61.64
	VHH	466.79	409.40	439.33	642.76	887.68	<u>755.74</u>	58.13
	AGR	467.58	403.53	433.01	616.64	842.03	718.85	60.24
FEMALES	BSHG	377.00	<u>300.27</u>	334.82	<u>547.98</u>	709.38	623.58	53.69
	FHG	369.09	373.28	369.35	588.87	690.75	635.21	58.15
	MHG	<u>449.85</u>	<u>463.46</u>	453.95	<u>671.18</u>	<u>819.94</u>	<u>739.43</u>	61.39
	IH	402.32	400.79	399.67	617.06	669.34	640.53	62.40
	VHH	405.04	<u>440.14</u>	420.89	616.22	746.30	677.13	62.16
	AGR	<u>464.35</u>	410.31	433.14	610.17	748.95	673.64	64.30

measurements are shown to be sexually dimorphic after comparing them in a Student's t -test ($p < 0.05$) in the entire available sample. Therefore, results are given by sex. Significant differences according to Games-Howell post-hoc tests after one-way ANOVAs comparing robusticities among subsistence groups, within sex, are designated with underlining. These results are also presented as box-plots in Figures 6.5 and 6.6. Note that, generally in both sexes, MHG groups have higher diaphyseal robusticities than any other subsistence category, and that, on the whole, the other subsistence categories are statistically homogeneous. Contrary to hypotheses, humeral or femoral robusticity is not significantly lower among agriculturalists in either sex.

A comparison among subsistence groups in the relative robusticity of the humeral

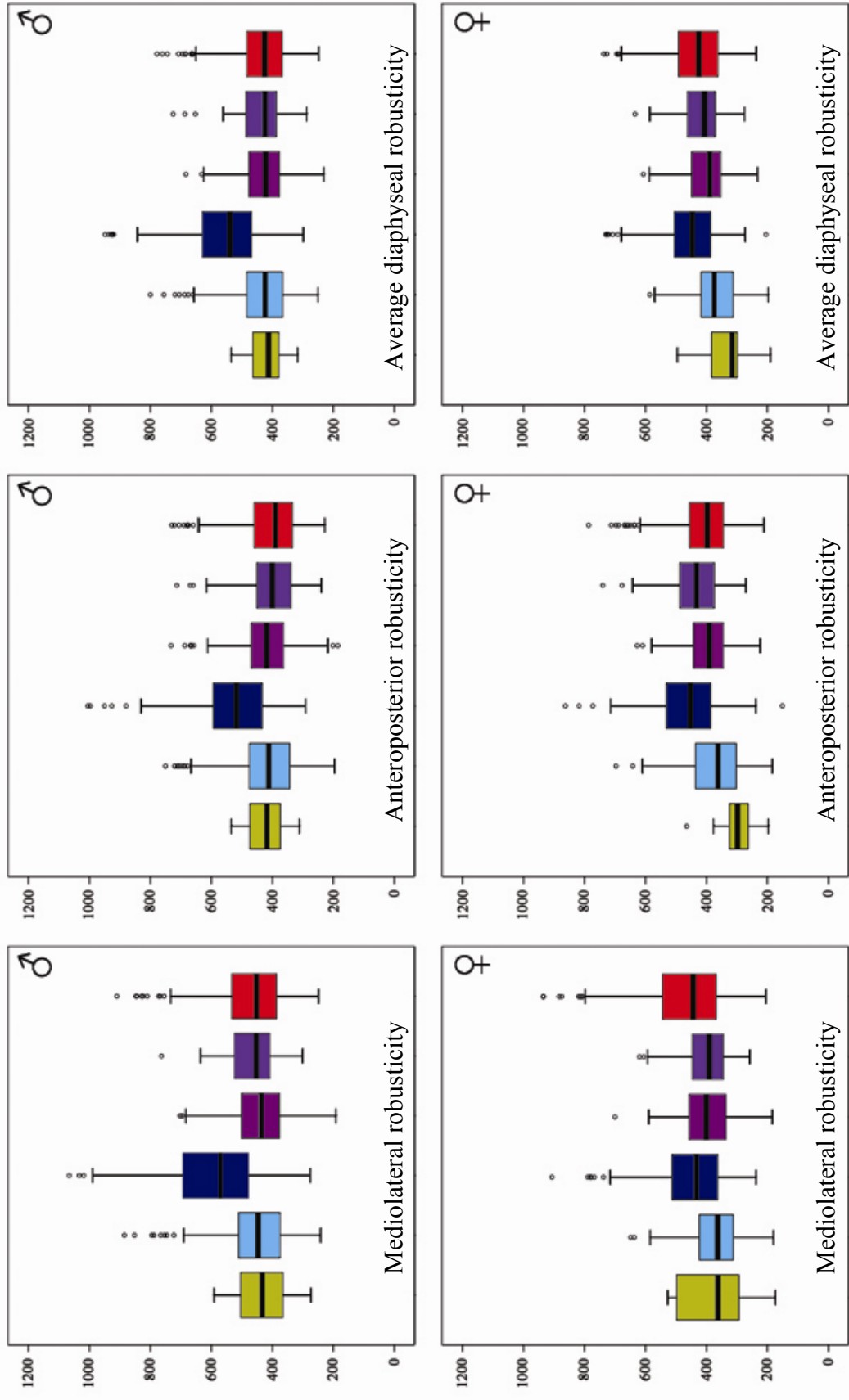


Figure 6.5. Humeral diaphyseal robusticity by subsistence group and sex. Gold, broad-spectrum hunter-gatherer; light blue, freshwater hunter-gatherer; dark blue, marine hunter-gatherer; purple, incipient horticulturalist; lavender, village horticulturalist/hunter; red, agriculturalist.

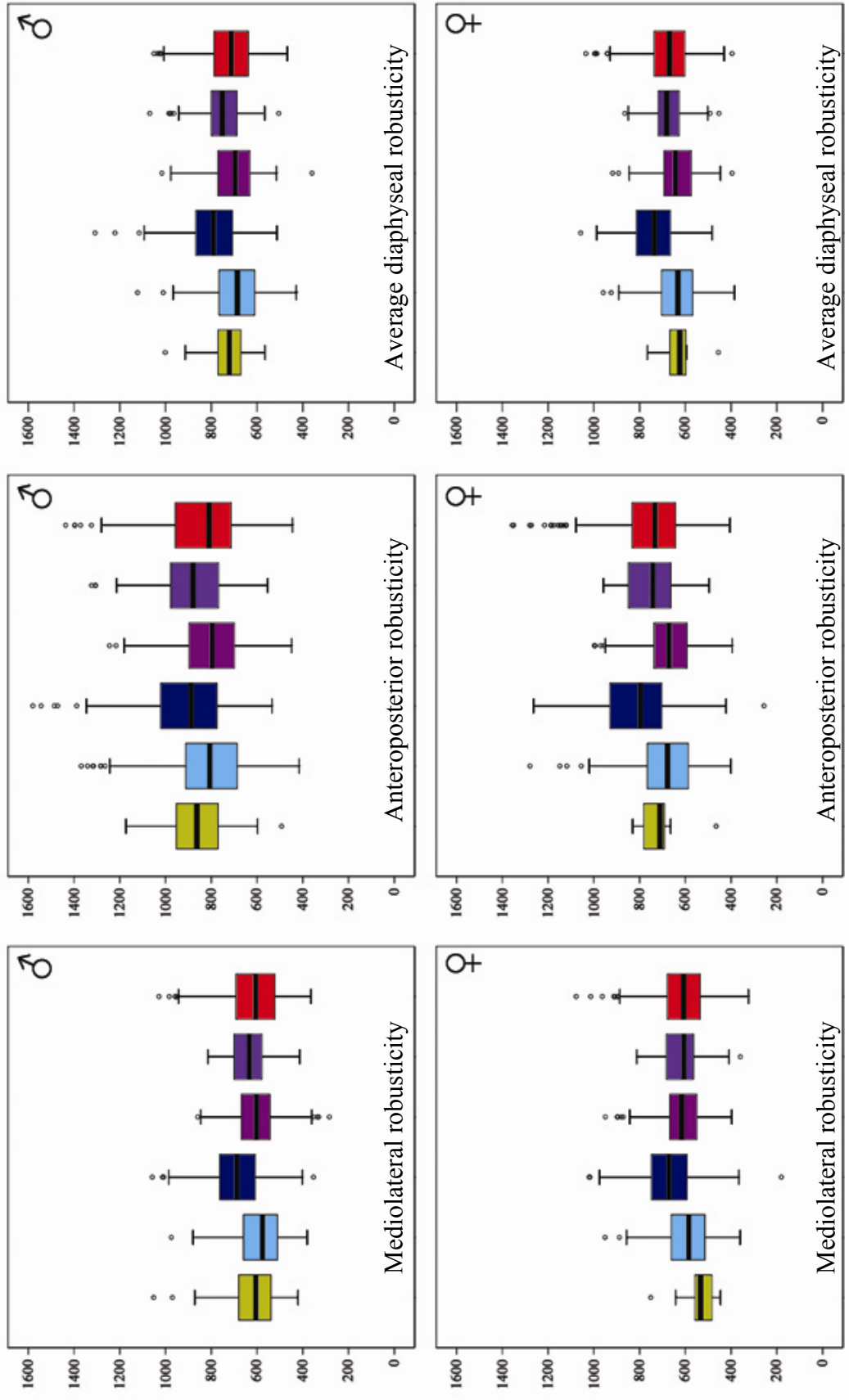


Figure 6.6. Femoral diaphyseal robusticity by subsistence group and sex. Gold, broad-spectrum hunter-gatherer; light blue, freshwater hunter-gatherer; dark blue, marine hunter-gatherer; purple, incipient horticulturalist; lavender, village horticulturalist/hunter; red, agriculturalist.

diaphysis compared to the femoral diaphysis is more revealing of differences among groups (Table 6.41). Note that, although both male and female MHG robusticities in the humerus and femur are, on the whole, significantly higher than the other groups, male marine hunter-gatherers have greater relative humeral robusticities compared with other groups, while females are not different. Also, both male and female broad-spectrum hunter-gatherers have relatively stronger femora than other groups (lower humeral robusticity/femoral robusticity ratios). Finally, it is interesting to note that female horticulturalists and agriculturalists have slightly higher relative robusticity in their humeral diaphyses than among hunter-gatherers (namely the inland groups), implying greater use of the upper limb relative to the lower limb in these subsistence groups. As noted in Chapter 3, more sedentary populations exhibit more equality in upper limb robusticity, and therefore equal division of labor, between the sexes.

It is also of interest to examine variation within subsistence groups. Regional variation in robusticities are reported for three groups—MHG, IH and AGR—in Tables 6.42.1-3. Of course, there may be even further variation within these general regions, but as the forms of subsistence were more homogeneous within regions than between regions (e.g., in technology used and resources exploited), these are reasonable comparisons to make.

Among marine hunter-gatherers, the male samples from Florida (the Southeastern U.S. sample) and the Texas coast have significantly higher femoral diaphyseal anteroposterior robusticity. The Floridian males also have significantly higher humeral robusticity. Note that the males from the Pacific Northwest, Florida and Tierra del Fuego have the relatively strongest upper limbs. Yaghan females from Tierra del Fuego are particularly notable for having potentially stronger humeri (without knowing cortical properties, robusticity can only suggest relative strength) than all of the other female MHG groups, and similar relative

Table 6.42.1. Regional comparisons of humeral and femoral diaphyseal robusticities among marine hunter-gatherers. Underlined values denote a dimension (or group of dimensions) that is significantly ($p < 0.05$) different from the all other groups' values in that dimension (assessed in one-way ANOVAs by sex); an asterisk represents values that are significantly different among the underlined values.

Sex	Region	Humeral diaphysis (50%)			Femoral diaphysis (50%)			Humerus/femur average diameter
		Mediolateral diameter	Anteroposterior diameter	Average diameter	Mediolateral diameter	Anteroposterior diameter	Average diameter	
MALES	Western Arctic	635.82	523.44	575.26	734.90	962.33	840.33	68.46
	Central Arctic	528.68	538.27	532.19	712.05	909.50	804.23	66.17
	Southeastern U.S.	<u>685.82</u>	<u>687.95</u>	<u>680.56</u>	712.97	<u>1042.83</u>	<u>865.44*</u>	78.64
	Pacific Northwest	613.10	523.83	565.25	670.71	<u>774.65</u>	<u>719.74</u>	78.54
	California	<u>505.86</u>	470.16	485.72	<u>624.95</u>	888.40	<u>744.49</u>	65.24
	South Texas	530.76	486.08	505.97	<u>670.79</u>	<u>1058.65</u>	<u>847.05*</u>	59.73
	Tierra del Fuego	594.89	483.10	535.74	649.26	875.86	754.92	70.97
FEMALES	Western Arctic	467.21	457.06	459.83	708.99	857.88	777.44	59.15
	Central Arctic	417.62	517.70	464.17	666.82	819.38	737.95	62.90
	Southeastern U.S.	440.16	478.21	455.73	689.98	853.38	765.30	59.55
	Pacific Northwest	462.04	448.85	453.34	647.29	<u>660.04</u>	<u>651.38</u>	69.60
	California	423.50	424.51	420.76	623.47	844.00	723.49	58.16
	South Texas	440.82	422.36	430.22	652.94	879.27	760.05	56.60
	Tierra del Fuego	<u>568.40</u>	<u>547.82</u>	<u>555.57</u>	694.95	839.75	762.63	72.85

Table 6.42.2. Regional comparisons of humeral and femoral diaphyseal robusticities among incipient horticulturalists. Underlined values denote a dimension (or group of dimensions) that is significantly ($p < 0.05$) different from the all other groups' values in that dimension (assessed in one-way ANOVAs by sex); an asterisk represents values that are significantly different among the underlined values.

Sex	Region	Humeral diaphysis (50%)			Femoral diaphysis (50%)			Humerus/ femur average diameter
		Mediolateral diameter	Anteroposterior diameter	Average diameter	Mediolateral diameter	Anteroposterior diameter	Average diameter	
MALES	Prairie & Eastern Woodlands	451.54	424.52	436.18	617.54	817.31	709.05	61.52
	Great Basin	453.38	364.12	404.91	566.08	819.30	677.56	59.76
	California	439.14	<u>438.09</u>	437.41	620.88	789.84	700.13	62.48
FEMALES	Prairie & Eastern Woodlands	414.45	<u>431.88</u>	<u>421.36</u>	600.81	697.52	646.31	65.19
	Great Basin	442.61	298.30	364.67	648.26	637.87	640.20	56.96
	California	388.36	381.64	383.41	627.65	643.74	633.28	60.54

Table 6.42.3. Regional comparisons of humeral and femoral diaphyseal robusticities among agriculturalists. Underlined values denote a dimension (or group of dimensions) that is significantly ($p < 0.05$) different from the all other groups' values in that dimension (assessed in one-way ANOVAs by sex); an asterisk represents values that are significantly different among the underlined values.

Sex	Region	Humeral diaphysis (50%)			Femoral diaphysis (50%)			Humerus/ femur average diameter
		Mediolateral diameter	Anteroposterior diameter	Average diameter	Mediolateral diameter	Anteroposterior diameter	Average diameter	
MALES	Prairie & Eastern Woodlands	493.31	429.76	459.69	<u>608.28</u>	849.99	718.42	63.99
	Southeastern U.S.	459.17	<u>449.79</u>	452.82	660.99	867.98	755.09	59.97
	U.S. Southwest	464.02	376.13	416.85	<u>586.11*</u>	843.88	703.11	59.29
	Guatemala	408.78	375.48	390.14	654.94	<u>954.86</u>	<u>790.11</u>	49.38
	Ecuador	<u>538.22</u>	429.68	<u>481.56</u>	744.60	829.89	<u>783.09</u>	61.49
	Peru	461.84	386.73	421.51	679.88	740.30	705.74	59.73
	Prairie & Eastern Woodlands	412.91	409.80	409.99	<u>595.04</u>	719.75	652.41	62.84
FEMALES	Southeastern U.S.	398.07	477.34	434.56	621.56	780.30	694.64	62.56
	U.S. Southwest	<u>543.41</u>	385.33	458.06	603.41	768.21	679.31	67.43
	Guatemala	<u>304.64*</u>	442.84	369.38	673.36	721.31	693.34	53.28
	Ecuador	516.04	415.28	463.32	623.91	681.06	649.92	71.29
	Peru	<u>336.12</u>	<u>348.45</u>	<u>340.86</u>	640.72	<u>610.92</u>	<u>622.09</u>	54.79

strength to Yaghan males. Perhaps these females were more active participants in rowing, harpooning, or other activities that were more sexually divided among other marine hunter-gatherer cultures.

Differences among the horticulturalists and agriculturalists, however, are not as substantial. Great Basin males and females both had considerably stronger humeral diaphyses in a mediolateral direction, but not anteroposteriorly. Mechanically, this dissimilarity likely points to a behavioral distinction among these samples, such as different food processing technologies. Compared to the variation among marine hunter-gatherers, though, the horticulturalists are homogeneous. There are a few more distinctions among agriculturalists, mostly due to the larger number of regions in which they are represented. The pattern in relative robusticity within the humeral diaphysis found among horticulturalists in the Great Basin is evident among the U.S. Southwest and Ecuadorian AGR groups, especially U.S. Southwest females. Again, this may be related to differences in food production (such as the use of manos and grinding stones in the U.S. Southwest). This is questionable, however, as Californian horticulturalists and most of the agriculturalists also employed grinding technologies for maize and other cultivars, though this pattern in robusticity is not observed. Note that the males and, especially, females from Ecuador exhibit high relative robusticity in the humerus, which may indicate significant differences in subsistence technology or the use of watercraft more often by this population than other samples considered (based on the similarly high relative strengths among the MHG). Also notice that both males and females from the Petén region in Guatemala had less robust humeri, though they had femoral diaphyseal robusticities that are on par with those reported for marine hunter-gatherers. As these were skeletons obtained from a sacrificial site, it is

possible that the individuals from this sample were not directly involved in agriculture. The same argument (non-involvement in agriculture) may be applied to female samples from Peru, whose humeri are also significantly less robust. Differences in social stratification or food processing technologies, however, are equally plausible explanations for these differences.

Generally, the pattern observed among the subsistence groups on the whole are upheld when comparing robusticities regionally. It is interesting that the incipient horticulturalists and the agriculturalists are quite similar in the apparent strength of their limbs, despite their differences in plant cultivation practices. Indeed, it is arguable that, with the exception of differences in humeral diaphyseal mediolateral robusticity among females (a pattern found in one regional IH group, however), the differences in robusticity that have previously been attributed to a shift to agriculture may have been associated with shifts to horticulture as well.

This is borne out, in part, by comparing sexual dimorphism among the subsistence groups (Table 6.43). In humeral diaphyseal robusticity, sexual dimorphism is notably lower among

Table 6.43. Sexual dimorphism indices for humeral and femoral diaphyseal robusticities, among subsistence groups, all time periods combined (except early Holocene skeletons).

Subsistence	Humeral diaphyseal robusticity			Femoral diaphyseal robusticity		
	Medio-lateral	Antero-posterior	Average	Medio-lateral	Antero-posterior	Average
BSHG	12.05	24.90	18.73	16.65	21.65	18.60
FHG	21.27	12.20	16.88	0.28	16.38	8.70
MHG	27.14	11.89	19.75	3.01	9.94	6.69
IH	10.35	5.10	7.79	-0.97	18.62	9.02
VHH	9.09	-10.57	0.34	6.37	18.23	12.49
AGR	1.98	-1.42	0.75	0.92	11.85	6.50

horticulturalists and agriculturalists in comparison with hunter-gatherers (and, in average robusticity, virtually is the same between the sexes for VHH and AGR groups). Note as well that the higher humeral mediolateral sexual dimorphism is likely a result of larger deltoid processes among males (which extends to 50% of the diaphyseal shaft length), especially among the MHG and FHG males. The pattern is less clear in femoral robusticity, except the general observation that males have much stronger femoral diaphyses in the anteroposterior plane. This may reflect more locomotor activity among males, or may be a more fundamental difference in the mechanics of male lower limbs versus females, who have wider pelves (see Chapter 3 and Discussion).

The patterns suggested by looking at relative humeral robusticity (Table 6.41) are also further demonstrated in these comparisons of sexual dimorphism. Among the hunter-gatherers, note that BSHG males are equally larger relative to females in both upper and lower limbs; this likely reflects differences in overall activity patterns. Both MHG and FHG have considerably less sexual dimorphism in femoral diaphyseal robusticity, but maintain high sexual dimorphism in the upper limb. This indicates continued sexual division in tasks among these groups (i.e., greater upper limb loading among males). An additional possibility for the lower amounts of sexual dimorphism in femoral robusticity in these two groups, compared with BSHG and horticultural groups, is that MHG and FHG groups relied less on terrestrial travel. Finally, note that agriculturalist and VHH groups have generally no sexual dimorphism in average humeral diaphyseal robusticity. These groups engaged in either less active behaviors or more sexually ecumenical activities. The fairly high sexual dimorphism in femoral average diaphyseal asymmetry among the VHH is interesting, and may be related to the male seasonal bison hunting activities enacted in these groups.

It is clear from these results that activity differences among these groups are visible in the robusticity of these two elements. The precise relationship of these to specific activities is uncertain, though there are strong indications that males in hunter-gatherer groups were more active relative to females in activities that stressed their limbs; it is likely that more water transportation usage among the hunter-gatherers resulted in greater upper limb strength among males. Analyses on bilateral directional asymmetry may help to clarify these patterns further.

6.4.4: Asymmetry

Directional asymmetry in limb bones, like robusticity, almost certainly relates only to activity¹⁴, and so its analyses are made with respect to subsistence groups alone. The focus of this subsection is on diaphyseal asymmetry, as it is likely the most functionally relevant to different mechanical uses of the limbs. Results are also briefly discussed for asymmetry among all of the limb dimensions, the mean and median values of which are reported in Appendix VII by sex and subsistence group. As explained in the Methods chapter, analyses of asymmetry are conducted using non-parametric statistics, with the exception of correlations between asymmetries of different dimensions, which are executed using residuals of natural log-transformed raw measurements (Auerbach and Ruff, 2006).

Median percent directional asymmetry (%DA) and percent absolute asymmetry (%AA) are presented in Table 6.44 for average 50% diaphyseal diameter asymmetries of each of the limb long bones (except for the fibula, which was not measured), by sex and subsistence group. Humeral and radial average 50% diaphyseal diameter %DAs are presented in Figures 6.7 and 6.8. Nearly all of the directional asymmetries for diaphyseal diameters are right-

¹⁴ There is certainly a genetic component related to directional asymmetry as well (see Auerbach and Ruff, 2006).

biased, and most are significantly different from zero, except for the femur (with two exceptions). Significantly right-biased tibial diaphyseal diameters contrast with more general worldwide and continental patterns previously described, in which tibial diaphyseal diameters tend to be significantly left-biased (Auerbach and Ruff, 2006). BSHG males tend to have more extreme directional and absolute asymmetries, especially in the upper limb. Additionally, the higher %DAs among BSHG males compared to females further implies more sex-specific tasks in upper limb use among individuals in this subsistence group, though this constitutes the smallest sample (36 males, 23 females).

Among males, humeral diaphyseal diameter %DAs are higher among the less sedentary subsistence groups (the VHH still actively hunted with regularity). In contrast, only FHG females tended to have greater (non-significant) preference for one limb. Note that MHG males had slightly lower amounts of %DA and %AA in their clavicles and humeri than the other hunter-gatherer groups; this may be attributable to more bimanual tasks. All subsistence groups except the BSHG are largely similar in the patterns of sexual dimorphism (Figure 6.7) in the humerus, though note the much greater difference between VHH males and females.

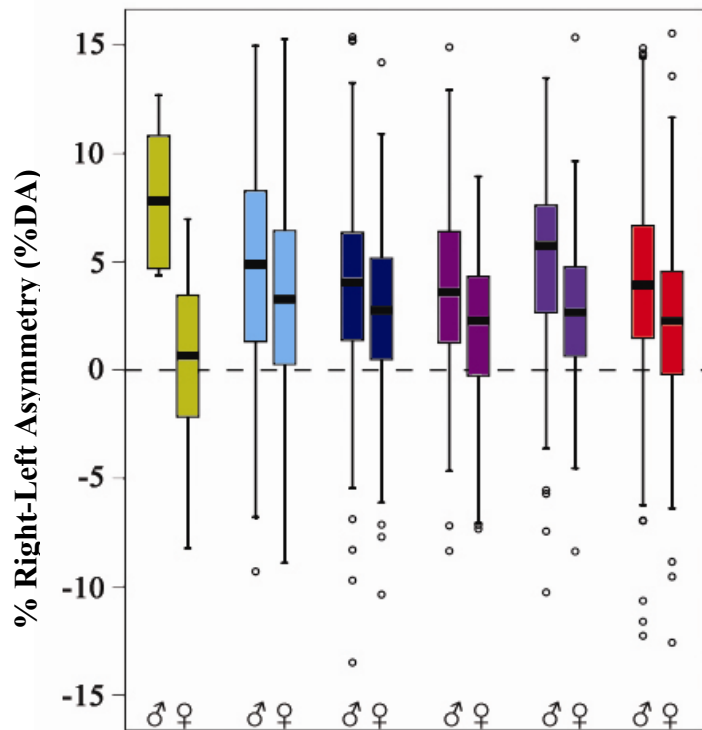
The VHH males still engaged in seasonal bison hunts (Wescott, 2001), and so were likely more mobile than the IH or AGR groups. If their hunting behavior was related to their higher directional asymmetry, though, the impact of this behavior is notably absent in robusticity comparisons for this morphology. This would suggest that the strength of their arms were no different from other cultivators, but their preference for one arm (or the incidence of unimanual tasks) was significantly greater.

Asymmetry in the forearms, however, is more distinctive among subsistence groups.

Table 6.44. Median percentage directional asymmetry and percentage directional asymmetry for average diaphyseal breadths (“_AD”), by sex and subsistence group. **Bolded** percentages designate significant differences of these groups from other groups in that dimension (after Mann-Whitney *U*-tests, $p < 0.05$). Underlined %DA values are significantly asymmetric (after a Wilcoxin signed-ranks test, $p < 0.05$). First letters of dimension abbreviations (followed by “AD”) correspond to element: C = clavicle, H = humerus, R = radius, U = ulna, F = femur, T = tibia.

Sex	Subsist. Group	Directional asymmetry (%DA)						Absolute asymmetry (%AA)					
		CAD	HAD	RAD	UAD	FAD	TAD	CAD	HAD	RAD	UAD	FAD	TAD
MALES	BSHG	<u>12.22</u>	<u>7.81</u>	<u>3.33</u>	2.60	0.09	<u>2.77</u>	10.71	8.01	4.14	4.22	2.96	3.69
	FHG	<u>3.79</u>	<u>4.86</u>	<u>2.00</u>	<u>2.66</u>	-0.40	<u>1.73</u>	5.72	5.55	4.05	4.96	2.76	3.82
	MHG	<u>2.75</u>	<u>4.05</u>	<u>2.51</u>	<u>3.43</u>	-0.51	<u>1.79</u>	4.97	4.68	3.91	5.19	2.65	3.61
	IH	<u>3.16</u>	<u>3.60</u>	<u>2.14</u>	<u>1.70</u>	-0.50	<u>2.60</u>	5.50	4.57	3.67	4.66	2.20	3.77
	VHH	<u>6.32</u>	<u>5.74</u>	<u>2.29</u>	<u>3.24</u>	-0.53	<u>1.34</u>	6.54	6.02	3.62	4.85	1.90	3.41
	AGR	<u>2.23</u>	<u>3.93</u>	<u>2.82</u>	<u>1.96</u>	-0.63	<u>2.50</u>	5.03	4.78	4.15	4.66	2.80	4.24
FEMALES	BSHG	1.35	0.67	-0.64	<u>-5.36</u>	-0.06	0.63	8.09	3.36	2.72	6.80	2.31	2.05
	FHG	<u>2.28</u>	<u>3.26</u>	<u>1.52</u>	<u>4.03</u>	0.30	<u>1.86</u>	4.47	4.75	3.78	4.93	2.50	3.12
	MHG	<u>1.92</u>	<u>2.77</u>	<u>2.09</u>	<u>2.84</u>	0.00	<u>1.26</u>	4.40	3.77	3.54	5.30	3.05	2.91
	IH	<u>2.40</u>	<u>2.28</u>	0.65	<u>1.20</u>	<u>-1.22</u>	<u>1.73</u>	5.00	3.52	2.99	3.94	2.73	3.75
	VHH	<u>1.95</u>	<u>2.66</u>	<u>2.29</u>	1.08	<u>-1.88</u>	0.83	5.03	3.89	3.19	4.49	2.95	3.35
	AGR	<u>2.17</u>	<u>2.27</u>	<u>2.57</u>	<u>1.93</u>	-0.66	<u>2.22</u>	5.00	3.43	4.52	4.48	2.79	4.40

Figure 6.7. Humeral average 50% diaphyseal directional asymmetry, by subsistence group. Colors: gold, BSHG; light blue, FHG; dark blue, MHG; purple, IH; lavender, VHH; red, AGR. Sexes are designated by male and female symbols at the bottom of the figure, beneath boxes.



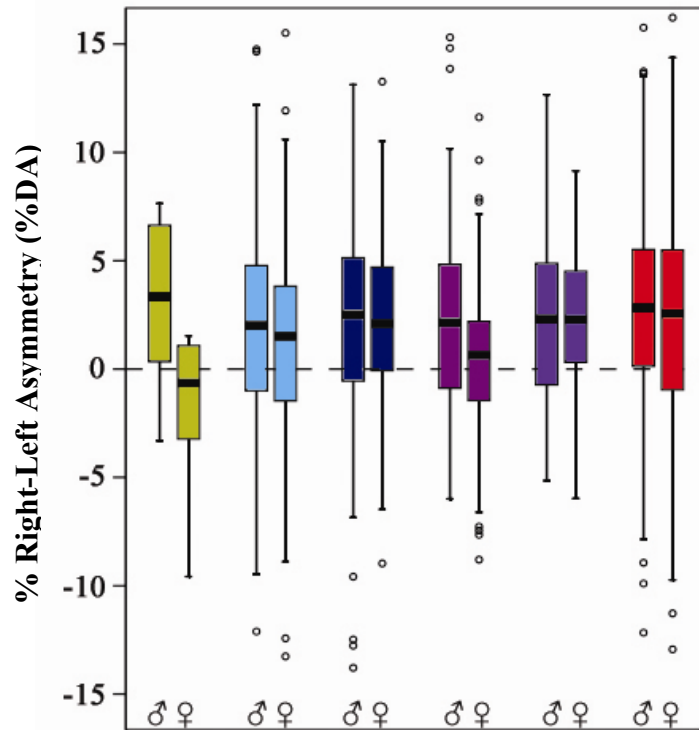


Figure 6.8. Radial average 50% diaphyseal directional asymmetry, by subsistence group. Colors: gold, BSHG; light blue, FHG; dark blue, MHG; purple, IH; lavender, VHH; red, AGR. Sexes are designated by male and female symbols at the bottom of the figure, beneath boxes.

Both male and female AGR samples exhibit higher amounts of radial diaphyseal diameter asymmetry, especially in comparison with the IH females (who did not have any significant directional asymmetry). Agriculturalist females also have significantly higher %AA in the radius. Male and female AGR samples are also more similar to each other in radial and ulnar asymmetry than to any other subsistence groups (Table 6.40 and Figure 6.8). FHG females and MHG males have significantly higher right-biased asymmetry in their ulnar diaphyseal breadths than other groups, but this is not reflected in the radial diaphyses (the relationship of these asymmetries to each other is further explored below).

The asymmetries of diaphyses in the lower limb are not as straight-forward. IH and VHH females have significant left-biases in their femoral diaphyseal breadths, which is unprecedented from previous research (Auerbach and Ruff, 2006). These are not small samples (IH females, $n = 146$; VHH females, $n = 144$), so the bias likely represents a

behavioral difference among these individuals (note that %AAs for this dimension are not significantly different from other groups). It is worth pointing out that both AGR sexes have higher %DA and %AA for the tibial diaphysis, and that this is right-biased.

Correspondence in these asymmetries is generally very low (Table 6.45). Bivariate correlations using residuals from regressions of left and right log-transformed measurements show that most of the diaphyseal asymmetries do not significantly (or even generally) covary. This is surprising, as general directionality in their asymmetries are similar, and the correlations presented are those for elements that are part of integrated units (i.e., the upper and the lower limbs). In the few instances in which significant (or large) correlations occur, these do not fit a coherent pattern. It is possible that, in comparing a wide diversity of groups, the covariance of these asymmetries is overridden by individual variation among a number of unrelated samples. Examining one of the larger samples—Indian Knoll—bears out this possibility. Although none are significant, correlations between diaphyseal breadth

Table 6.45. Bivariate correlations of residuals for average diaphyseal diameter measurements. Significant correlations ($p < 0.05$) are designated in **bold**.

Sex	Correlation pair	Pearson's r -coefficient					
		BSHG	FHG	MHG	IH	VHH	AGR
♂	Clavicle – humerus	0.003	0.121	0.097	0.007	0.199	0.059
	Clavicle – radius	0.080	-0.129	0.062	0.075	0.453	-0.021
	Clavicle – ulna	0.056	0.105	0.010	-0.179	0.054	0.051
	Humerus – radius	-0.365	0.131	0.082	0.185	0.421	-0.006
	Humerus – ulna	0.284	0.047	0.013	-0.021	0.117	0.004
	Radius – ulna	-0.013	0.084	0.157	0.258	-0.109	0.061
	Femur – tibia	-0.013	-0.170	0.085	0.189	-0.033	0.010
♀	Clavicle – humerus	0.541	-0.005	0.036	0.136	-0.113	0.068
	Clavicle – radius	-0.263	-0.027	-0.260	0.273	-0.416	-0.097
	Clavicle – ulna	0.300	0.017	-0.052	0.109	0.259	-0.016
	Humerus – radius	-0.178	0.066	0.171	0.180	-0.274	0.103
	Humerus – ulna	0.159	-0.066	0.048	0.037	-0.041	0.104
	Radius – ulna	-0.066	0.515	0.117	0.216	0.470	0.081
	Femur – tibia	0.194	0.139	0.050	-0.017	0.151	0.028

directional asymmetries are moderate for the clavicle and humerus ($r = 0.238$), humerus and radius ($r = 0.381$), humerus and ulna ($r = 0.128$), and tibia and femur ($r = -0.462$) among Indian Knoll males. Notably, the ulna and radius independently vary ($r = -0.080$), despite supposedly being part of the same functional unit.

In other dimensions (Appendix VII), when all subsistence groups are considered together, the overall pattern of asymmetry matches global patterns for a subset of these measurements (Auerbach and Ruff, 2006; Auerbach and Raxter, in press). Females have more asymmetry in upper limb bone lengths (except for the clavicle), while males have higher asymmetry (%DA and %AA) in average diaphyseal breadths. Articular dimensions' percentage asymmetries fall between the amounts of asymmetry in maximum lengths (smaller) and diaphyseal breadths (larger). In the lower limb, percentage asymmetries tend to be smaller and of mixed direction, with notable exceptions for tibial average diaphyseal breadth and average tibial distal articulation area. Perhaps most importantly, subsistence groups do not differ in asymmetries of maximum lengths or articulations as much as they do in diaphyses.

6.5: Application: Stature estimation equations

One practical application of the analyses of variation among American skeletons is the development of group-specific stature estimation equations. More explicitly, knowing what morphologies vary among New World samples, and potentially what environmental factors might be related to those variances, better informs which morphologies must be taken into consideration when developing stature estimation equations. Only those elements that directly contribute to stature (i.e., the elements in the Fully technique) will be considered in estimating stature in this section.

Yet, what have the analyses of this chapter suggested about morphological variation and its relationship with climate, geography, and subsistence? Much of this is left to discussion in the next chapter, but some salient points can be made here, focusing on those morphologies directly related to stature:

- Stature itself does vary among subsistence groups, with broad-spectrum hunter-gatherers and all cultivator groups generally taller than freshwater and marine hunter-gatherers. Whether this is directly related to subsistence, population history, or an underlying climatic factor (e.g., temperature) remains unresolved.
- Similarly, lower limb length and torso height also tend to vary considerably among samples differing in subsistence and in climate, but often in concert.
- There is a suggestion that crural index, excluding the extreme morphologies of the high latitude samples, matches population history more often than climate in the Americas (and more often among males). Curiously, there is no clear association between crural index and subsistence, despite its connection with both stature and lower limb length. This is interesting because early analyses in this chapter demonstrated that crural index increases with positive scaling between the tibia and the femur; taller individuals generally have longer tibiae relative to femora. A bivariate correlation of crural index and lower limb length elucidates this particular riddle, however; crural index is positively, significantly correlated with lower limb length, but the correlation coefficient is low ($r = 0.261$). Thus, though there is a tendency for longer lower limbs to have relatively longer tibiae, this is not a high correlation. However, tibial maximum length remains much more variable than femoral bicondylar (and, by extension, maximum) length.

- Based on the missing element analyses (Chapter 5), cranial height is somewhat independent of the height of the postcrania. Furthermore, cranial module (of which cranial height is a component) varies with geography, temperature, and, to a lesser extent, subsistence.

Thus, based on these preliminary conclusions, a general set of criteria may be designated in a protocol for comparing groups, and thus used to determine how best to group samples in the estimation of stature. Focus is placed on the lower limb, given its more common preservation in archaeological contexts and significant contribution to total stature. Given the tendency for lower limb length to vary among samples, differences among samples in absolute lower limb length (femoral bicondylar length plus tibial maximum length) relative to the Fully technique estimated statures is an initial criterion for associating groups in stature estimation equations. Sample groupings that have relatively short or long lower limbs for their statures will be considered together. Crural indices, given their potential link with both population history and climate, as well as more common availability in skeletal samples, are then used as a further means for checking groupings of samples before developing stature estimation equations. (Relative torso height does vary among samples, but there is no coherent relationship between this morphological index and any tested environmental factor or geographic variation.) Lower limb length has slightly greater variation among males, so differences among males are favored in grouping samples (though females, too, are examined). ANOVAs with Games-Howell post-hoc tests, comparing relative lower limb lengths (to stature), are used to determine groups. These groupings are assessed visually using log-transformed lower limb length and Fully statures plotted against each other (Figure 6.9).

Once sample groupings have been determined, the process of stature estimation is straightforward. Stature estimation equations are generated by least squares regressing of skeletal elements against statures determined from the Fully technique. Equations are generated for lower limb length (femoral bicondylar length and tibial maximum length), and for femoral bicondylar length alone. An inherent limitation to the application of this method is the availability of skeletons with estimated Fully statures within the sample groupings. No attempt is made to estimate statures for groups of samples lacking skeletons with Fully technique estimated statures. Also, because of limited sampling, no South American equations are calculated, as the majority of available south American statures come from one site (the necropolis at Ancón, Peru).

The plotted mean log-transformed lower limb lengths and statures in Figure 6.9 reveal some trends among samples within regions. Among both males and females, statures are generally lower in the arctic, Pacific Northwest and Western Plateau, and the majority of these samples have relatively short lower limb lengths relative to their statures. An ANOVA comparing relative lower limb lengths to stature among samples bears this out. Samples from the Western Arctic and Pacific Northwest have significantly ($p < 0.05$) shorter relative lower limb lengths than all temperate samples, with the exception of individuals from the Great Basin. This pattern is stronger among males. On the opposite end of the graphs, it is interesting to note that some samples from the Prairie & Eastern Woodlands (specifically, those from the Illinois River Valley), South Texas and the Great Plains tend to have relatively longer lower limb lengths relative to stature, a pattern that again is supported by an ANOVA and is stronger among males. All other temperate groups fail to significantly differ in relative lower limb lengths. Although there are individual sample exceptions to these

Figure 6.9. Log-transformed mean lower limb length plotted against log-transformed mean Fully-estimated living stature for samples, by sex, labeled by region. Black lines represent isometry between lower limb length and stature.

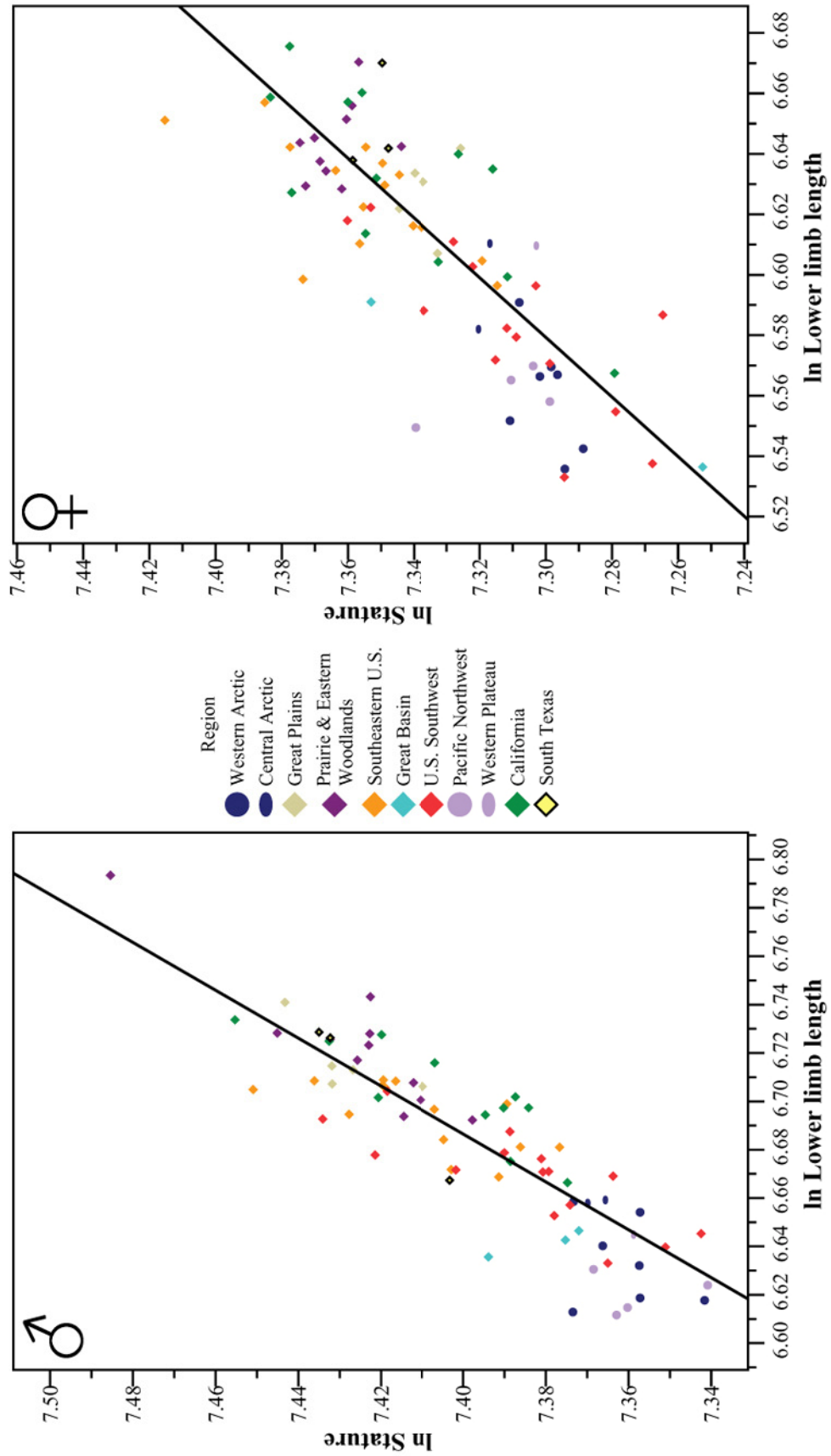


Table 6.46. Sex-specific stature estimation equations, listed by samples used in their calculation. Equations yield living stature in centimeters. See text in this section for an explanation of how samples were aggregated into groups, and how equations were determined. FBL, femoral bicondylar length (mm); TML, tibial maximum length (mm).

Regions	Samples	Sex	<i>n</i>	Femur equation	SEE (%SEE)	Femur and tibia equation	SEE (%SEE)
Arctic and subarctic	All samples from Alaska (including the Aleut), British Columbia, Northeastern Manitoba, and Nunavut	Male	157	$0.225 \times \text{FBL} + 62.73$	2.90 (1.83%)	$0.128 \times \text{FBL} + 0.126 \times \text{TML} + 59.86$	2.62 (1.66%)
		Female	117	$0.213 \times \text{FBL} + 64.82$	2.99 (2.01%)	$0.117 \times \text{FBL} + 0.120 \times \text{TML} + 64.00$	2.82 (1.90%)
“Temperate” North America	All samples from Arkansas, Arizona, California, Florida, Georgia, Kentucky, Louisiana, Maine, Massachusetts, Nevada, New Jersey, New Mexico, Ohio, and Tennessee	Male	303	$0.254 \times \text{FBL} + 52.85$	2.55 (1.56%)	$0.160 \times \text{FBL} + 0.126 \times \text{TML} + 47.11$	2.35 (1.44%)
		Female	256	$0.267 \times \text{FBL} + 44.80$	2.58 (1.68%)	$0.176 \times \text{FBL} + 0.117 \times \text{TML} + 41.75$	2.40 (1.56%)
“Great Plains”	All samples from Illinois, Southern Manitoba, South Dakota, and Texas	Male	91	$0.244 \times \text{FBL} + 58.23$	2.05 (1.22%)	$0.188 \times \text{FBL} + 0.076 \times \text{TML} + 54.13$	1.94 (1.15%)
		Female	70	$0.244 \times \text{FBL} + 55.85$	2.58 (1.65%)	$0.168 \times \text{FBL} + 0.104 \times \text{TML} + 50.55$	2.41 (1.54%)

patterns, and females have more “noise” in these patterns, these are the general trends that are used to develop three general sets of stature estimation equations. The grouping of arctic, Pacific Northwest and Western Plateau samples is further supported by the significantly lower ($p < 0.01$, $F = 56.95$) crural indices among samples from these regions compared with all other regions. Mean crural indices among samples from the Great Plains, South Texas and Illinois River Valley samples do not significantly differ from the U.S. Southwest, the Great Basin, or California, nor do they significantly differ from each other, however, and are among the highest crural indices in North America (on average, with an index over 85).

Stature estimation equations, determined by sex, are listed in Table 6.46 with standard errors of the estimate (both SEE and %SEE), and the samples from which they are generated. The specific samples used are not listed in the interest of brevity, though all samples with Fully-estimated statures from these regions were employed in calculating the equations. These broadly-defined equations should be applied to the regions from which they have been developed.

Generally, these equations perform well on the skeletons with Fully technique estimated statures—percent SEE’s range between about one and two percent. In order to further assess the utility of these new equations, a series of paired *t*-tests are used to compare the performance of the new “Temperate” equations for the Ohio samples and U.S. Southwest samples with the two currently available, New World specific equations that were originally devised for these or similar samples (Genoves, 1967—U.S. Southwest; Sciulli et al., 1990—Ohio River Valley). The results of these comparisons are shown in Table 6.47. It should be noted that these equations are tested on subsets of the total samples used to generate the equations. Therefore, these comparisons are not tautological. These results demonstrate that,

Table 6.47. Variation in stature estimations (cm) using new equations (“Temperate”) and previously-available equations, compared against Fully technique estimated statures using paired *t*-tests. Standard deviations (SD) of the mean difference between estimates and the Fully technique estimated statures are given, as well as the total dispersion of the 95% confidence interval.

Sample	Sex	<i>n</i>	Fully estimated stature mean (cm)	New femur-only stature estimation equation		New femur and tibia stature estimation equation		Genoves (1967) (Arizona) / Sciulli et al. (1990) (Ohio) stature estimation	
				Mean (SD)	95% CI	Mean (SD)	95% CI	Mean (SD)	95% CI
Eastern Arizona	♂	39	161.42	160.66 (2.6)	1.68	161.25 (2.6)	1.68	160.60 (3.6)	2.33
	♀	27	150.55	150.77 (2.0)	1.56	151.23 (1.7)	1.35	151.02 (3.05)	2.41
Ohio River Valley	♂	22	166.83	165.19 (2.1)	1.90	165.35 (2.0)	1.80	151.34 (3.5)	3.08
	♀	17	158.14	156.41 (2.9)	3.02	156.57 (3.0)	3.05	142.83 (3.5)	3.56

though the Genoves (1967) equation provides a good estimate of statures, it has a greater dispersion about the mean compared with the new estimation equations. Contrastingly, the Sciulli et al. (1990) equations severely (and significantly) underestimate statures for both males and females, and also have a greater range of estimations.

How accurate are the equations for the arctic and Great Plains? Respectively, the best available (but sample-inappropriate) equations for these regions are the “mongoloid” stature estimation equations developed by Trotter and Gleser (1958) and the Ohio equations of Sciulli et al. (1990), respectively. These equations have been used to estimate statures for samples from these two regions (e.g., Auerbach and Ruff, 2004). As in Table 6.47, these equations are evaluated using paired *t*-tests, comparing their accuracy on the Neo-Aleut and Sadlermiut (Trotter and Gleser “mongoloid”), and Mobridge Arikara and Dickson Mound Mississippians (Sciulli et al.). The results are presented in Table 6.48 for the new stature estimation equations, Trotter and Gleser’s “mongoloid” equation (Neo-Aleut and

Sadlermiut), and Sciulli et al.’s Ohio Native American equations (Arikara and Dickson). It is apparent from these results that the “mongoloid” equation yields a systematic overestimation of statures, and is less accurate for females (which makes sense, as the equation was developed using males). The Sciulli et al. (1990) equations—as also demonstrated in Table 6.47 on the Ohio samples—result in a systematic underestimation of “Plains” sample statures. The new equations work quite well on samples that are not typical for their respective regions (namely, the Sadlermiut and the Arikara), and produce biologically-reasonable estimations of statures. It is worth remarking that there is slightly less accuracy in estimating female statures, but this is expected given the greater dispersion of females in the scatterplot of lower limb length versus stature (Figure 6.9), and the slight incongruence of male and female patterns in relative lower limb length.

Table 6.48. Variation in stature estimations (cm) using new equations and previously-available equations, compared against Fully technique estimated statures using paired *t*-tests. Standard deviations (SD) of the mean difference between estimates and the Fully technique estimated statures are given, as well as the total dispersion of the 95% confidence interval.

Sample	Sex	<i>n</i>	Fully estimated stature mean (cm)	New femur-only stature estimation equation		New femur and tibia stature estimation equation		Trotter & Gleser (1958)/ Sciulli et al. (1990) stature estimation	
				Mean (SD)	Range	Mean (SD)	Range	Mean (SD)	Range
Neo-Aleut	♂	17	159.31	158.29 (1.8)	1.82	157.73 (1.7)	1.80	163.74 (3.7)	3.78
	♀	10	147.17	146.13 (1.7)	2.45	145.97 (1.8)	2.51	155.71 (3.0)	4.33
Sadlermiut	♂	22	158.74	160.36 (2.9)	2.60	159.34 (2.7)	1.81	167.36 (4.3)	3.78
	♀	14	151.07	151.71 (3.1)	3.54	151.12 (2.6)	3.02	160.98 (4.8)	5.57
Mobridge	♂	15	168.89	168.37 (2.2)	2.41	168.24 (2.0)	2.18	153.68 (3.1)	3.45
	♀	11	154.76	154.51 (2.9)	3.90	154.67 (2.3)	3.05	139.34 (2.8)	3.75
Dickson	♂	21	168.98	169.00 (1.9)	1.69	168.61 (1.9)	1.73	154.58 (2.7)	2.43
	♀	16	158.79	156.89 (2.5)	2.65	156.74 (2.2)	2.35	142.64 (4.3)	4.60

These results, overall, support the use of these new equations, and the methods used to develop them. In addition, these new equations provide broadly-applicable stature estimations for regions of the New World in which no specific formulae have been available previously. The broad application to North American regions has been demonstrated. Unfortunately, there are still some regions (e.g., all of the South American samples¹⁵) for which stature estimation equations cannot be synthesized, or for unique samples, such as the early Holocene skeletons.

6.6: Skeletons of the early Holocene

Early Holocene American skeletons have been omitted from the previous examinations of environment in relation to morphological diversity. This is because their relationship with more recent samples is uncertain, because isolated skeletons cannot be justifiably designated “sample means,” and because most parametric tests cannot incorporate them. Thus, they are examined separately in this section.

Morphological variation among early Holocene skeletons: general description:

Skeletons from the first two millennia of the Holocene in North America are exceedingly rare and fragmentary. All analyses are restricted in this section to North America because of the uncertainty of the relationship of and likely significant difference in subsistence patterns of South American humans from the early Holocene with North American humans (Munford et al., 1995; Gruhn, 2005), and because only one South American early Holocene skeleton is present in the dataset (São Raimundo, Brazil). Furthermore, comparative analyses are limited to males, as the only North American females in the sample (Wilson-Leonard,

¹⁵ It is inadvisable to apply these North American-derived equations to any Mesoamerican or South American samples at present.

“Midland Woman,” and Gordon Creek) are extremely fragmentary and, though some morphologies have been calculated for them (and are given in Appendix V), do not share common morphologies. Their measurements are included for archival purposes. Only two North American male skeletons are nearly complete: Spirit Cave, Nevada, and Kennewick, Washington. The majority of the remaining early Holocene skeletons in the POD and EOD consist of few, isolated elements. Given the antiquity of these skeletons and their generally unplanned or unintentional discovery (Powell, 2005), any data that allow for morphological comparisons among these skeletons are exceptional.

Fortunately, five adult male skeletons, dating from between 10,000 and 8100 yBP, have been excavated that preserve bones from which some of these morphological traits may be extrapolated. Although some information on these is in Appendix I, a brief review of the individuals is useful. The Kennewick skeleton, which has become infamous in the debate over the repatriation of human remains from North America, has been extensively described (Owsley, in press; Chatters, 2000), and dates to circa 9400 yBP. Central western Nevada’s Spirit Cave skeleton, dated using mummified hair and preserved textiles, has a similar antiquity of circa 9430 yBP (Tuohy and Dansie, 1997). Near that site, and approximately 100 years more recent than Spirit Cave, the skeletal remains from Wizard’s Beach were found close to Pyramid Lake (Dansie, 1997). To the northwest, early Holocene remains dating to approximately 8300 yBP were uncovered in southern central British Columbia along Gore Creek (Cybulski et al., 1981). Finally, the adult skeletal remains from Horn Shelter (located in central Texas along the Brazos River) date to a time period very close to Spirit Cave and Wizard’s Beach, at 9980 \pm 370 radiocarbon yBP (Young et al., 1987).

It should be noted that multiple other isolated skeletal elements and fragmentary

individuals uncovered in North America are measured in the POD (e.g., Warm Mineral Springs, Little Salt Spring). Few of these, however, present any dimensions for useful comparison, and the association of elements in some (namely, Warm Mineral Springs) is uncertain. Those mean morphological data for these skeletons that are available are reported in Appendix V, but will not be used in analyses in this section.

Spirit Cave, Horn Shelter, and Kennewick were measured by me in data collection for the POD. The Spirit Cave skeleton—which had been mummified (the right arm is still articulated)—was in very good condition, and all measurements were taken without need for estimation¹⁶. The Horn Shelter skeleton, however, had a fragmentary pelvis, few vertebrae, a distally-broken and eroded left radius, a shattered left femoral neck, and some postmortem breakage on both tibiae. The lengths of the tibiae were estimated by comparing both sides. The majority of the Kennewick skeleton was measurable without need for estimations, with the exception of the os coxae; the methods used for their measurement are described in detail in Chapter 5. Although the remains from Wizard's Beach are still under the receivership of the Nevada State Museum (where Spirit Cave is also held), permission was not obtained to measure these remains. Instead, measurements taken by Drs. Douglas Owsley and Richard Jantz were kindly provided for this skeleton. Direct observations by the author on the Gore Creek skeleton were not possible, as these remains have been reburied. Dr. Jerome Cybulski, however, obtained a number of measurements from this skeleton, which he published with colleagues in 1981. No other measurements were taken from this skeleton (Jerome Cybulski, personal communication).

The derived morphologies for the five early Holocene male skeletons are provided in

¹⁶ Spirit Cave is unusual, however, as his skeleton has an extra vertebral element. This is either a thoracized L1 or an additional thoracic vertebra. If it were a thoracized L1, he would have had six lumbar vertebrae in addition to a cranial shift in vertebrae. Otherwise, his vertebral column exhibits a caudal shift.

Table 6.49. Derived morphologies for the early Holocene male skeletons.

Sample	Cranial index	Cranial module	Facial index	Nasal index	Relative torso height	Brachial index	Crural index
Horn Shelter	74.33	153.33	172.25	83.95		79.06	83.68
Spirit Cave	71.65	157.00	174.62	80.07	49.33	79.33	82.92
Kennewick	74.82	156.89	143.44		45.04	75.94	86.16
Gore Creek							84.47
Wizard's Beach						76.99	86.22

Sample	Absolute torso height	Lower limb length	Upper limb length/torso height	Interlimb index	Bi-iliac breadth	Stature	Body mass
Horn Shelter		786.00		71.85			69.14
Spirit Cave	381.56	773.50	139.82	68.97	279.00	160.84	61.63
Kennewick	386.70	858.50	155.03	69.83	281.00	171.74	73.66
Gore Creek		829.00					
Wizard's Beach		853.00		76.85			76.90

Table 6.49. As stated in the last section, no reliable mathematical stature estimation equations can be created for skeletons of their antiquity. Without the necessary elements by which to employ the revised Fully technique, statures are not available for Horn Shelter, Wizard's Beach, or Gore Creek. In addition, only Spirit Cave and Kennewick have measured bi-iliac breadths. Because of these limitations, the Grine et al. (1994) femoral head body mass estimation formula has been chosen to calculate body masses for all of the early Holocene males. Gore Creek's only applicable measurements are tibial maximum length and femoral maximum length, which was converted to femoral bicondylar length using a OLS regression formula calculated using all of the available skeletons from the POD. (It should be noted that the Spirit Cave body mass estimations using the mechanical and

morphometric methods differ by less than five kilograms, and Kennewick by less than one kilogram.)

Comparing the morphological traits in Table 6.49 reveals that, even within this very small sample, the morphologies of these early Holocene males were not homogeneous. Horn Shelter, Spirit Cave and Kennewick all had relatively narrow calvaria, as well as fairly low nasal indices in the first two skeletons. Spirit Cave and Horn Shelter, despite a geographic separation of nearly 2000 kilometers between their burials, had similar facial, brachial and crural indices. Both had relatively wide faces, high brachial indices and moderate crural indices. Likewise, Kennewick and Wizard's Beach had similar limb proportions (though their geographic separation was only a fourth of the distance between Horn Shelter and Spirit Cave). It is noteworthy that Gore Creek's crural index is more similar to those of Spirit Cave and Horn Shelter, though Gore Creek lived in a similar environment to Kennewick. (As Gore Creek lived 1000 years after Kennewick and may not have been related, this comparison is tenuous.) Note that, despite these differences, both Kennewick and Spirit Cave had wide bodies (see below), and all but Spirit Cave were massive individuals, compared to the mean male body masses for more recent groups in the POD (see Appendix V). Spirit Cave and Kennewick also differ in the relative length of their torsos: Kennewick's was low compared with Spirit Cave who, while being shorter than Kennewick by nearly 11 cm (~4.33 inches), had a long torso relative to his lower limb length. Kennewick also had a relatively narrower body, relative to stature.

Without comparing these patterns of variation with those of more recent humans, however, these conclusions lack context. It cannot be asserted if this variation represents as much diversity as that found in more recent groups. Also, as these are individual samples, no

statistical tests may be used to assess their differences. It is interesting, though, that Kennewick and Wizard's Beach seem to have similar morphologies (more than Horn Shelter and Spirit Cave to each other or to these other two skeletons), insofar as both were massive individuals with moderate brachial indices and high crural indices, as well as lower weight for their statures than Horn Shelter.

Morphological variation in the early Holocene in context:

In order to place the variation among the early Holocene males into context, their morphological traits are compared with those of males from seven more recent groups from the Americas. Rather than use all of the available males in the POD and EOD for comparison, a select few samples are used. These comparative sites are chosen to present a cross-section of the hunter-gatherer variation in the POD: Windover Pond, Ellis Landing, Indian Knoll, Coast Salish, Tigara (Point Hope), the Sadlermiut, and the Huari buried at Ancón¹⁷. Given the antiquity of the Windover site and the large sample size it provides, examining variation among its individuals and with the early Holocene skeletons is a potentially enlightening and relevant comparison. Indian Knoll and Ellis Landing represent distinct Archaic cultures existing between at least 5000 and 4000 yBP, and more temperate environments than the Windover males. The Tigara and Sadlermiut are selected to represent the extreme morphologies found at the high latitudes (ostensibly the regions through which humans might have migrated en route to the Americas). The Coast Salish are of special relevance, as they lived 9000 to 8000 years after but geographically in the same region as Kennewick and Gore Creek, both discovered on the Western Plateau.

¹⁷ Though individuals from the Huari Empire were agriculturalists, they are employed as representatives of a more tropical morphology (compared with the North American samples).

Table 6.50. Means for male morphologies among the New World samples employed in comparison with the early Holocene male skeletons

Sample	Cranial index	Cranial module	Facial index	Nasal index	Relative torso height	Brachial index	Crural index
Windover Pond	73.94	152.00	173.11	89.54	44.75	79.47	85.50
Ellis Landing	77.87	154.67	179.79	93.05	45.78	78.73	83.82
Indian Knoll	76.67	150.10	173.13	84.66	45.99	77.14	84.51
Coast Salish	82.63	147.26	175.02	90.75	48.66	78.30	83.25
Tigara	72.76	153.57	163.45	78.44	46.50	74.91	82.86
Sadlermiut	73.84	154.16	168.76	70.44	46.09	71.97	80.49
Ancón	78.16	148.86	174.05	74.90	49.15	77.86	85.58

Sample	Absolute torso height	Lower limb length	Upper limb length/torso height	Interlimb index	Bi-iliac breadth	Stature	Body mass
Windover Pond	370.85	819.92	153.37	68.73	265.4	166.32	65.00
Ellis Landing	359.24	808.62	156.86	69.60	277.1	162.72	71.11
Indian Knoll	366.92	798.09	153.73	70.87	258.7	161.35	60.32
Coast Salish	369.54	758.29	147.26	71.62	263.1	157.06	62.91
Tigara	361.77	780.39	146.00	67.71	280.1	159.29	70.43
Sadlermiut	358.12	779.96	146.70	67.33	273.1	158.74	73.20
Ancón	373.82	762.54	143.12	70.04	269.2	158.16	68.02

Analyses do not consider climate or subsistence, but instead morphological variation alone. Table 6.50 reviews the means of the morphological traits of the temporally more recent groups. A cursory examination of these data indicates greater ranges among these samples than are present among the early Holocene males. A one-way ANOVA, with a Games-Howell post-hoc test for group differences, indicates that the Sadlermiut have significantly lower brachial and crural indices than all other groups (including the Tigara),

and significantly greater body masses than all other groups except the Tigara and individuals from Ellis Landing. Interestingly, only Windover males were significantly taller than the other groups, and both Windover and Indian Knoll males had significantly narrower bodies relative to stature. In fact, the individuals buried at Windover Pond, based on their means, had morphological traits indicating a warm-climate adaptation compared with the other North American groups. It is worth noting that, despite their tall stature, the Windover males had relatively very short torsos. Contrastingly, the Ancón skeletons have significantly longer torsos, relative to lower limb length, than the North American groups. The environmental correlates for this variation, as analyzed in this chapter, are ambiguous. The taller statures are possibly related to subsistence, though the variation in relative torso height is a possible indicator of variation that covaries with climate.

How does this variation among more recent groups compare with the differences observed among the five skeletons from the early Holocene? Figure 6.10 presents log-transformed bivariate plots of radius maximum length against humerus maximum length, and of tibia maximum length against femoral bicondylar length. The OLS regression lines are for two recent groups at the extremes for the ranges of these indices—the Sadlermiut and the Huari. The most ancient skeletons—the early Holocene and Windover males—tend to have high brachial indices, but more intermediate (though high) crural indices. This is also the pattern for the Coast Salish individuals from the Western Plateau. Note that the early Holocene skeletons all plot close to the range of variation among the skeletons from Windover in both indices.

The intralimb patterns suggested in the previous section among the early Holocene skeletons are upheld. Spirit Cave and Horn Shelter have brachial indices similar to those

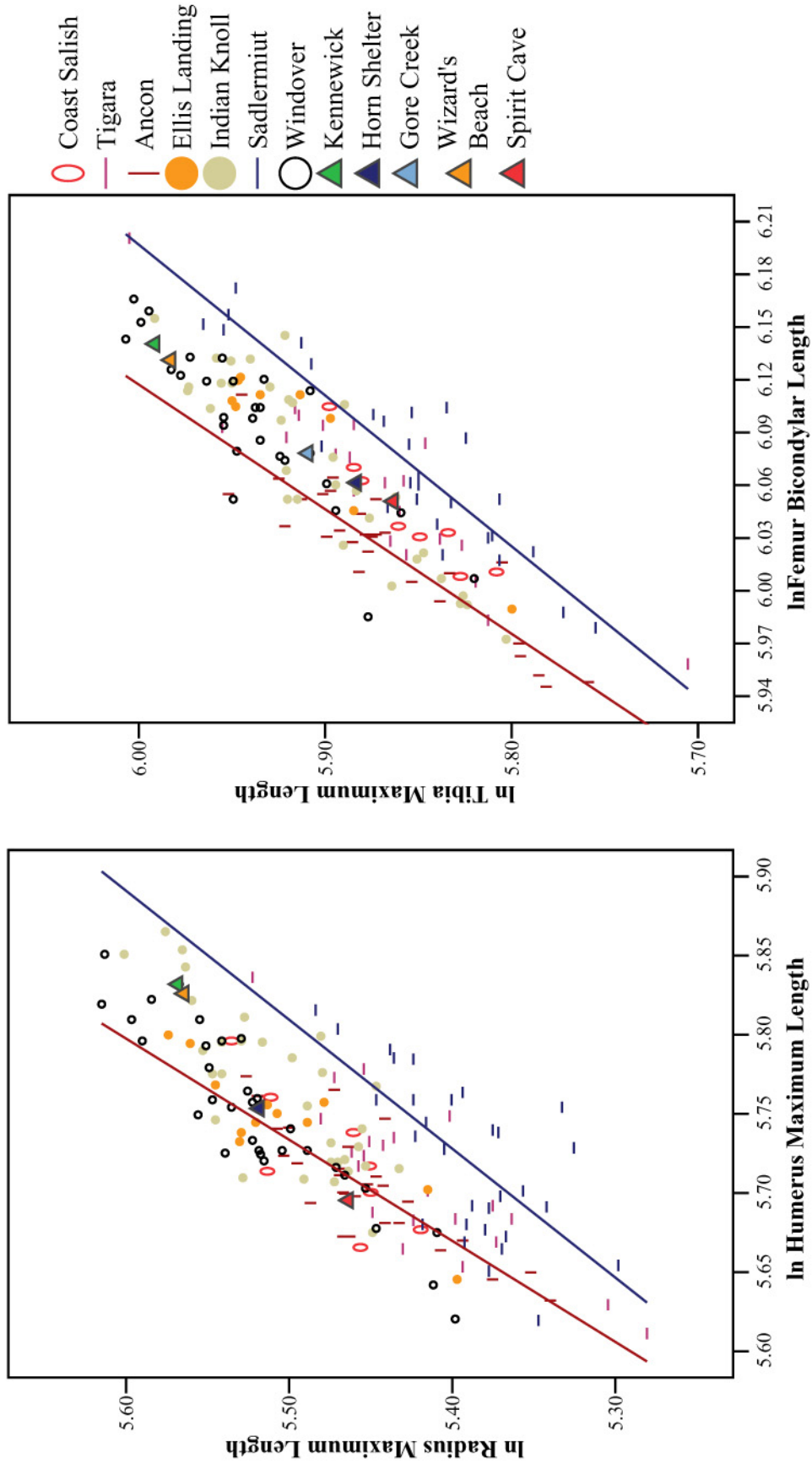


Figure 6.10. Brachial and crural indices for early Holocene, Archaic, and recent male skeletons. Blue OLS regression line, Sadlermiut; dark red regression line, Ancón.

found among the Huari from Ancón, while Kennewick and Wizard's Beach are intermediate (though outside the size range) between the Sadlermiut and the Peruvians. In crural indices, contrastingly, all five early Holocene males have more intermediate proportions, though, unlike the brachial indices, Kennewick and Wizard's Beach have more similar proportions to the Huari than Spirit Cave, Horn Shelter, or Gore Creek.

An examination of group means for estimated body mass in Table 6.50 reveals Horn Shelter, Kennewick and Wizard's Beach to be as massive as the arctic groups, whereas Spirit Cave's body mass is within the lower end of the distribution, closest to the mean for males from Indian Knoll. As noted in temporal and regional comparisons of morphology with climate, the body masses of males from Ancón are also among the highest for the more recent groups.

It was previously established that, among the early Holocene males, Horn Shelter appeared to be relatively short for his body mass, compared with Spirit Cave, Kennewick, and Wizard's Beach (Table 6.49). Comparisons with the more recent groups bear out this slight, but interesting difference (Figure 6.11). Unlike the patterns observed in the intralimb indices, Horn Shelter plots outside of the range of the males buried in Windover Pond, and in the more intermediate area between the arctic groups and Windover and Indian Knoll. Again, it is evident that, although Spirit Cave is considerably shorter than Kennewick and Wizard's Beach, all three have similar body masses relative to their statures, which in turn are similar to the skeletons in Windover and Indian Knoll.

This pattern seems to contrast with the relative body breadths of Spirit Cave and Kennewick. Recall that Spirit Cave appeared to be more "stocky"—wider bodied relative to his stature—compared with Kennewick. Assessing their relative body breadths against the

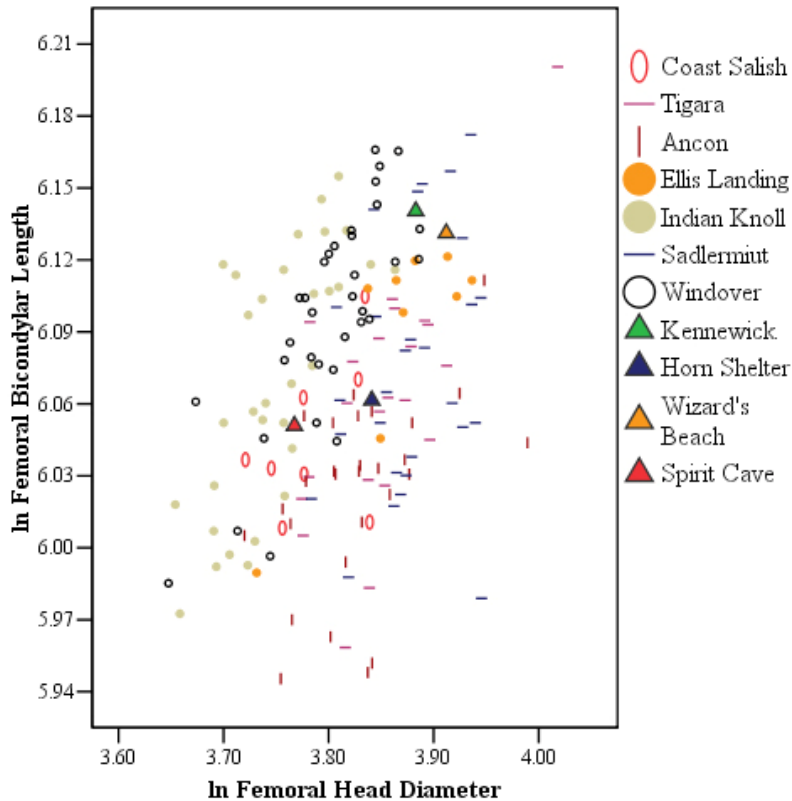


Figure 6.11. Femoral head diameter (as a proxy for body mass) relative to femoral bicondylar length (as a proxy for stature) among male early Holocene and recent male skeletons.

more recent groups in Table 6.49, this assertion is maintained. Spirit Cave had a relative body breadth similar to those found in the artic, whereas Kennewick once again has a similar morphology to Windover and to Indian Knoll, as well as to individuals from the Northwestern Plateau. Despite the body shape difference between these two early Holocene individuals, however, their purported climatic adaptation is similar; thus it may be hypothesized that within similar climatic conditions, body breadth remains constant even as stature varies. As exemplified in the extreme cases of colder climates represented by the Tigara and Sadlermiut, body breadth is higher, therefore decreasing the surface area relative to mass. Note that, throughout the Americas, bi-iliac breadth does not covary often with climatic factors, and so this relationship may not be variable in the short periods of time humans have occupied the Americas. Yet, Spirit Cave and Kennewick both have body

breadths like those found among the Point Hope Tigara, and less like those of Windover or Indian Knoll. Thus, Kennewick may have had a similar appearance in relative body breadth to the individuals living in eastern Florida a thousand years later, but his absolute bi-iliac breadth, in context, aligns him to groups from colder climates.

Given the subtle but notable variation in specific morphological traits among the early Holocene individuals in these comparisons, then, how do they relate in an holistic perspective? A discriminant function analysis (DFA) is one method to address this. Ratio values (without arcsine transformation), unfortunately, invalidate the statistical assumptions of DFA, and so linear measurements have been chosen for the analysis. Log-transformed humeral maximum length, radial maximum length, femoral bicondylar length, femoral head diameter, and tibial maximum length are chosen for consideration in the DFA, as four of the five early Holocene males have these dimensions. The early Holocene skeletons are not factored into determining the discriminant functions. The resulting analysis produces five functions, the first two of which explain 89.6% of the total variance and are chosen for further investigation. The correlation coefficients of variable loadings on these first two functions are provided in Table 6.51, and their discriminant scores are presented in a bivariate plot in Figure 6.12. Function 1's highest correlations are with radial length and

Table 6.51. Function loadings for discriminant function analysis. Asterisk denotes the largest absolute correlation between each variable and any discriminant function.

Variable	Function 1	Function 2
log _e Humeral maximum length	.194	-.370
log _e Radial maximum length	.539*	-.066
log _e Femoral bicondylar length	.040	-.391
log _e Tibial maximum length	.247	-.142
log _e Femoral head diameter	-.415	.305

femoral head diameter; individuals plotting higher on this axis have relatively longer forearms and are less massive (and therefore are, ostensibly, more “warm” climate adapted). It is interesting that femoral length has little effect on this function, implying again that variation in stature does not discriminate strongly among these groups (and that, even with one agriculturalist group, stature does not vary enough to significantly discriminate among these recent samples). The higher contribution of tibial length, relative to femoral length, may be an effect of greater variability in the length of the tibia. Function 2 is more ambiguous, though it appears to relate to size: individuals plotting positively on this axis are more massive relative to their body lengths, though these are admittedly weak relationships.

The bivariate plot in Figure 6.12 demonstrates that the DFA is able to yield some group distinctions. The arctic groups generally separate out from the lower-latitude groups on Function 1, while there is little separation in the second function. It is interesting that the early Holocene males clearly plot with the lower latitude groups. Indeed, the DFA assigns Kennewick, Horn Shelter and Wizards Beach to Indian Knoll, while Spirit Cave is more likely assigned to Windover. The probabilities of these assignments are reported in Table 6.52. Both Kennewick and Wizard’s Beach have percent probabilities over 60% of group membership with Indian Knoll, while Horn Shelter has a probability under 50%. Given the distinctions among these skeletons reported above, this difference in probability of group affiliation is not surprising. Also, although Spirit Cave is assigned to Windover, the probability is very low (22%); none of the more recent samples have morphologies analogous to those exhibited by Spirit Cave. In addition, the early Holocene males all plot within the range of males from Windover Pond, though, as well as close to the range of those from Ellis Landing. Both of these, perhaps coincidentally, were Archaic coastal-dwelling

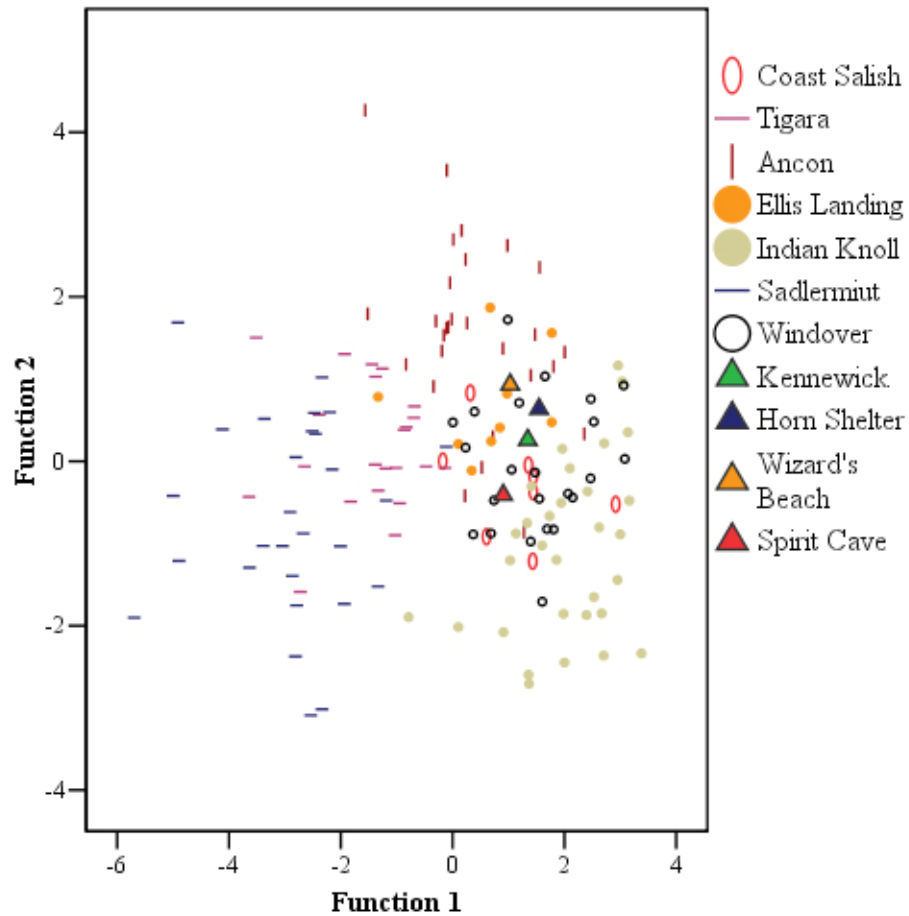


Figure 6.12. Discriminant function analysis bivariate plot for limb element maximum lengths and femoral head diameter. Function 1, $\lambda = 3.47$, 71% of total variance. Function 2, $\lambda = .908$, 18.6% of total variance. See Table 6.51 for function loading correlation values.

Table 6.52. Highest assigned percent probabilities of group membership of early Holocene males to more recent samples

Early Holocene skeleton	Recent sample affiliation	Percent probability
Kennewick	Indian Knoll	66.80%
Horn Shelter	Indian Knoll	42.65
Wizard's Beach	Indian Knoll	68.53
Spirit Cave	Windover	22.27

groups. Note that Kennewick and Spirit Cave also plot within the range of the Coast Salish.

In light of what had been determined about the relationship of morphologies in relation to environmental variables, what do all of these results imply about the males living in the early Holocene? The variation among them is similar to the range of variation observed in more recent temperate North America, though Kennewick and Spirit Cave are wider-bodied than many of the more recent samples, except the most northern latitude samples. This may be related to population history more than to the climates in which they lived. Crural index, as shown in previous analyses, covaries less than brachial index in relation to climatic factors. This may explain the dissimilarity in intralimb indices in these skeletons. Note that the Coast Salish and Ellis Landing have low crural indices compared with other groups with similar brachial indices. Therefore, the generally higher crural indices for the early Holocene skeletons again may be a reflection of population history as much as they relate to temperature and precipitation. Spirit Cave has an inexplicably long torso—in part due to an extra vertebral element—with torso-to-limb proportions unlike any other sample except the Huari at Ancón. Kennewick has, in contrast, torso-to-limb proportions more like those of other temperate North American samples (further supporting his clustering with Indian Knoll), but he is taller and heavier than many recent samples. Body mass and stature both relate to subsistence and, in a more limited way, to climate, though how to interpret these in relation to the differences between Kennewick and Spirit Cave, or the other early Holocene males, would require too much conjecture. The narrow crania of Kennewick, Horn Shelter, and Spirit Cave, though not analyzed at length, may relate to the general trend for dolichocephaly in the past. However, their large cranial size and moderate to lower nasal indices covary somewhat with cooler climates, but higher precipitation rates than

experienced by the high latitude samples.

Overall, the morphology of these early Holocene males indicates a mosaic of morphologies, different because of varying relationships with climate, subsistence, and population history. Although not as variable as more recent samples from North America, they reflect a range of variation similar to that observed in this small sampling of temperate North American groups. In short, the few early Holocene males were not homogeneous, but fit within the variation observed in the later Americas. How this total variation in the Americas compares to Old World variation, however, awaits the final set of analyses.

6.7: American variation in the context of Europe and Africa

As evident throughout the various analyses of this chapter, most of the morphologies considered among humans who lived in the New World are heterogeneous. Observing the Americas broadly—through time and across geography—there are apparent latitudinal clines in body mass, intralimb indices, nasal index, and, to lesser extents, cranial index, bi-iliac breadth, lower limb length (though this is confounded with longitude). Observed more finitely, however, it is evident that these apparent clines are largely created when comparing extreme morphologies in the north to more extreme morphologies in equatorial latitudes, or, in the case of lower limb length and stature, at lower latitudes. Variation among samples from the mid-latitudes (e.g., between 50 and 20 degrees latitude), and, in some cases, all lower latitudes (under 50 degrees latitude) is muddled, as it follows few clinal patterns (except for the aforementioned weak longitudinal cline in stature). This variability is already apparent among the earliest available samples, though it cannot be determined if the extreme morphology of the most northern samples was present prior to 2500 yBP. It is important to

note, however, that the morphologies of high latitude samples are not apparent in the earliest samples from lower latitudes.

Nevertheless, even though patterns and possible causes are difficult to decipher, there has been considerable variation in most morphologies among humans in the New World. Facial index is the only notable exception, where its variability is limited among samples and rarely reaches significance. Yet, how “considerable” might be the significant differences in morphology when placed into the context of human samples globally?

Comparisons with recent European and African humans mostly sampled by Dr. Trenton Holliday for his dissertation (1995) provide one context. As noted in the Methods, these data—the COD—provide measurements that allow contextual comparisons for intralimb indices, relative torso height (and its component dimensions), interlimb index, relative upper limb length/torso height, bi-iliac breadth, and body mass. Analyses using these data are conducted regionally against the established American regions; the COD are divided into five regions: Northern Europe (the Norse and Roman-British), Southern Europe (all other European samples), North Africa (Nubia and Egypt), West Africa (the San and “West Africans”), and East Africa (Dr. Christopher Ruff’s Ugandan data). Though statistics are not conducted because of research restrictions, reference is also made in this section to limb and pelvic data collected by Dr. Jay Stock from Southern Siberia (near to Irkutsk) dating to circa 7000 yBP.

Brachial index, crural index, relative torso height, and bi-iliac breadth are compared visually using box-plots among the American regions and the five COD regions in Figure 6.13 through 6.16 on the following pages. New World regions are demonstrated to the left sides of these graphs, and the Old World regions are to the right, separated by a vertical line.

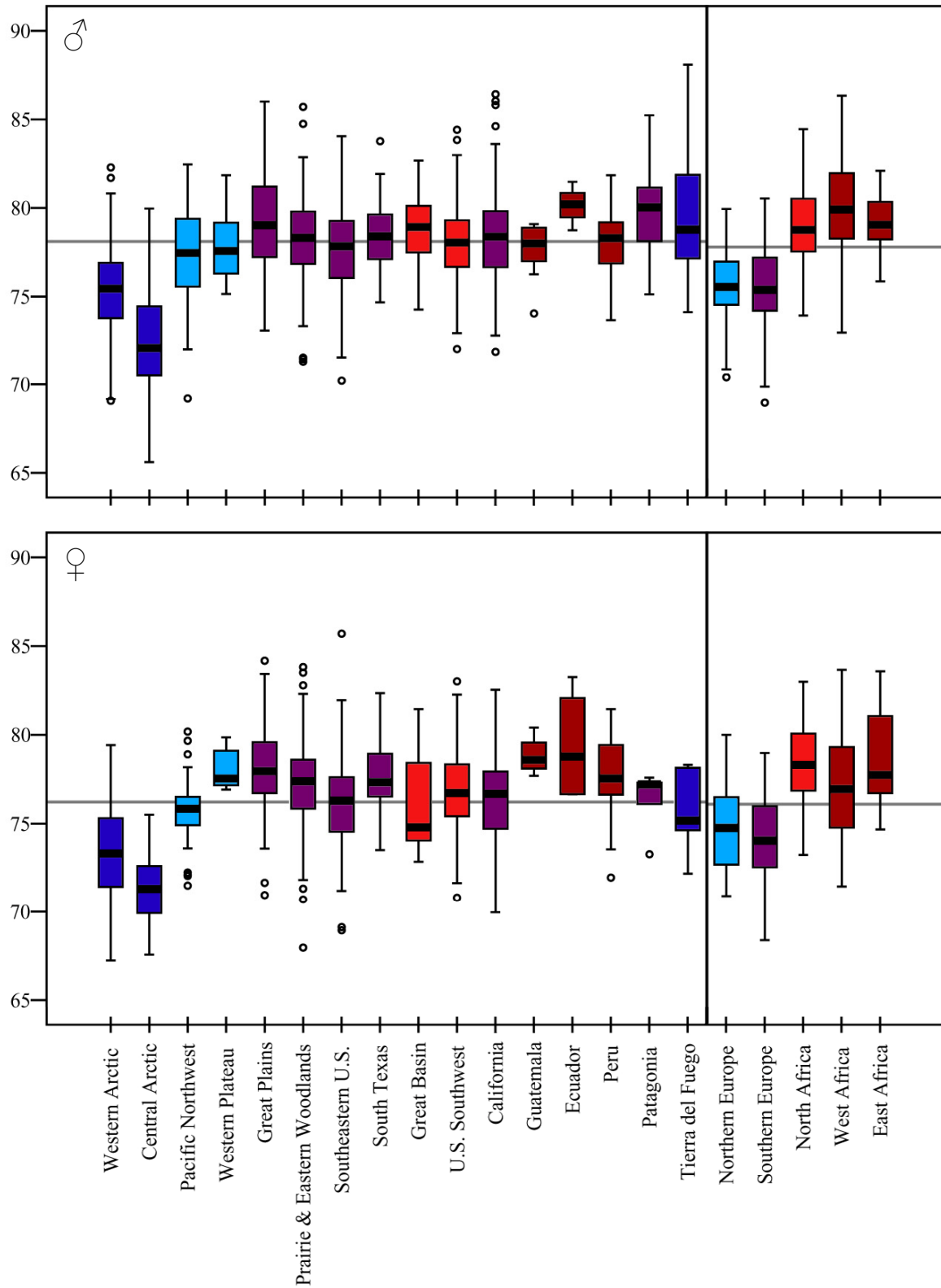


Figure 6.13. Brachial indices compared between the Americas and the Old World. General climates are represented by: dark blue, arctic; light blue, “subarctic”; purple, temperate; bright red, warm temperate; dark red, tropical. Horizontal grey lines, brachial index medians for each hemisphere.

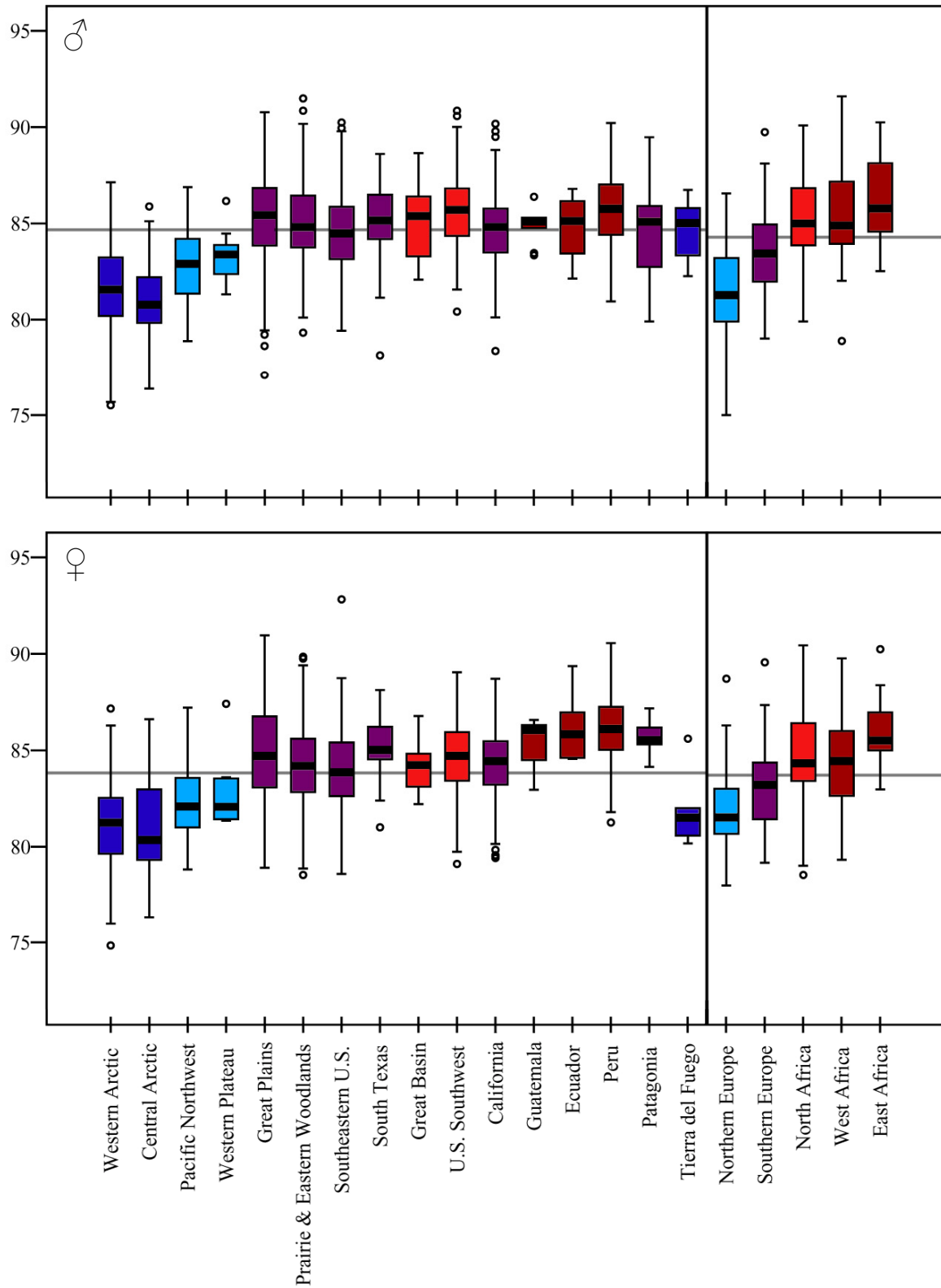


Figure 6.14. Crural indices compared between the Americas and the Old World. General climates are represented by: dark blue, arctic; light blue, “subarctic”; purple, temperate; bright red, warm temperate; dark red, tropical. Horizontal grey lines, crural index medians for each hemisphere.

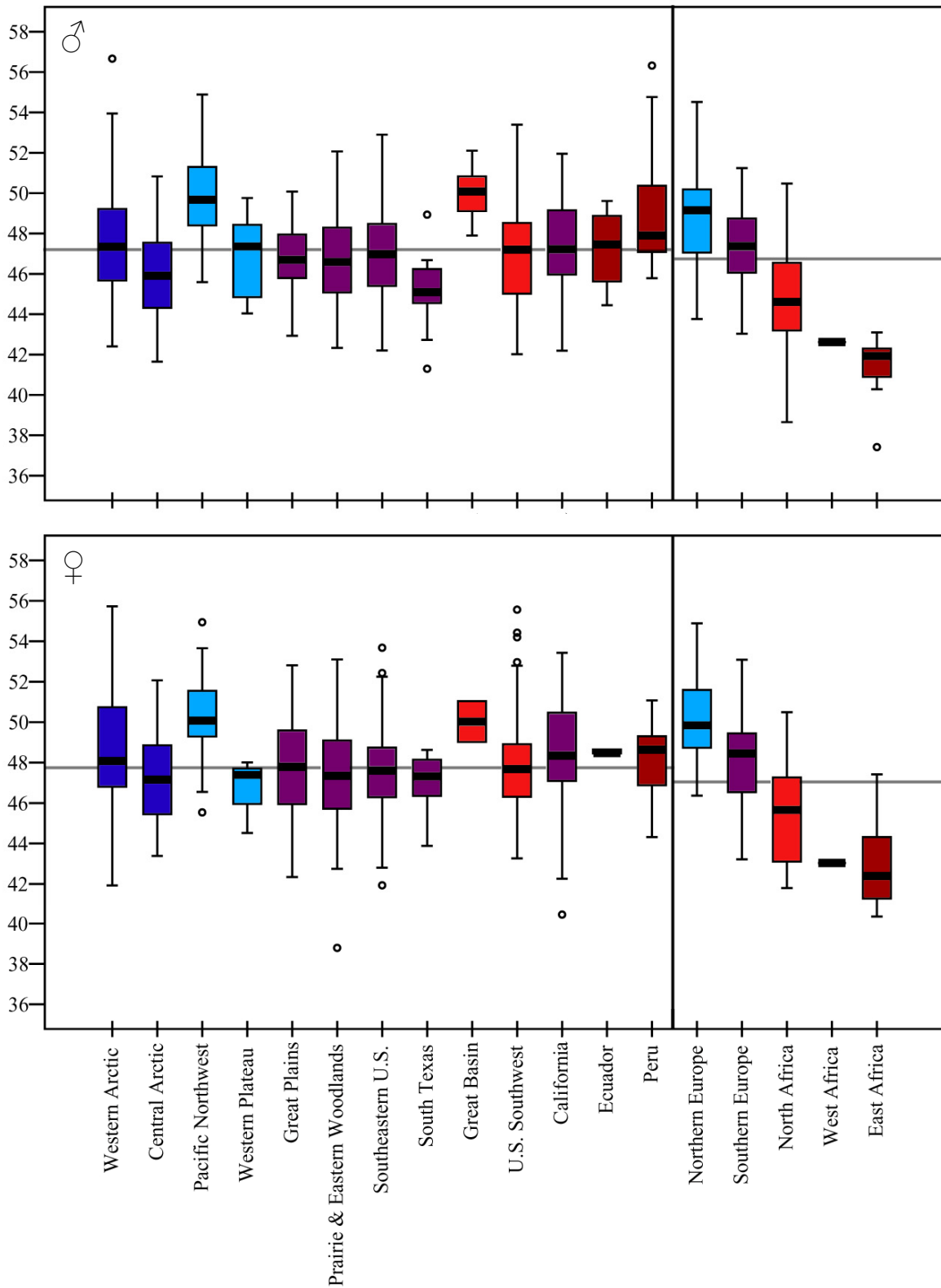


Figure 6.15. Relative torso height (RTH) compared between the Americas and the Old World. General climates are represented by: dark blue, arctic; light blue, “subarctic”; purple, temperate; bright red, warm temperate; dark red, tropical. Horizontal grey lines, medians for each hemisphere.

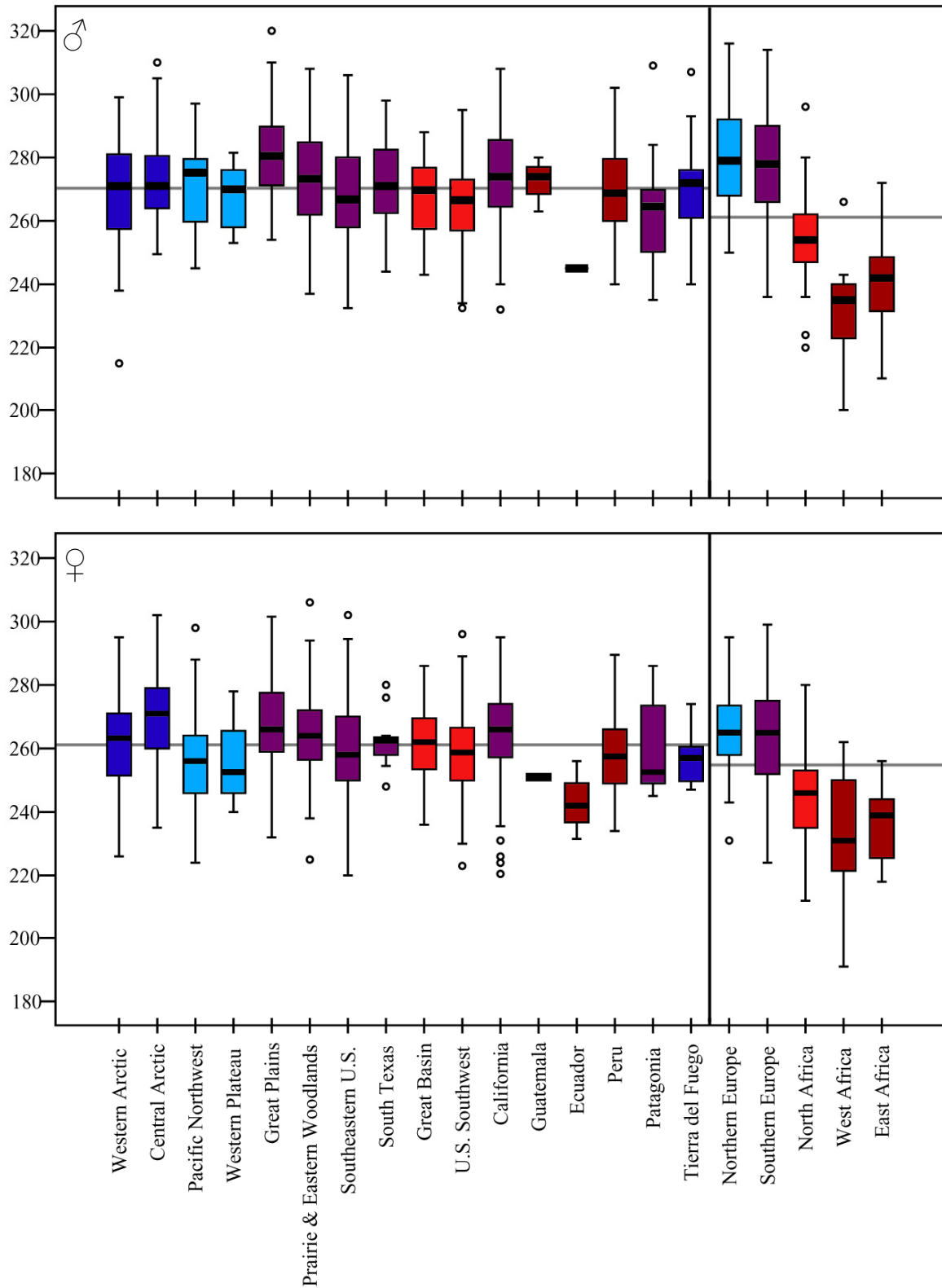


Figure 6.16. Bi-iliac breadth (BIB) compared between the Americas and the Old World. General climates are represented by: dark blue, arctic; light blue, “subarctic”; purple, temperate; bright red, warm temperate; dark red, tropical. Horizontal grey lines are BIB medians for each hemisphere.

Note that the grey horizontal lines indicate the medians for the entire New World sample and for the entire Old World sample. As the COD combines samples dating to the last 4000 years, all time periods are combined in the New World (excluding the early Holocene skeletons). (The majority of New World samples, as has been established previously in this chapter, date to the last 4000 years, and none of these morphologies demonstrate a temporal trend, so removing those from before this time would not significantly change the patterns observed in Figures 6.13–6.16).

The geographic clines in these morphologies are evident as described by Holliday (1995); higher latitude samples have wider bodies, shorter limbs and relatively shorter distal limb segments. These strong clines contrast noticeably with weaker or no clinal patterns among the New World regions. Of these four morphologies, only crural index indicates an ecogeographic cline (especially among females), as well as South American regions in female brachial index. This corroborates, visually, the results of many of the previous climate and geography analyses. It is interesting that, in all cases, the total New World sample has higher medians for these morphologies than the Old World. At least in these four morphologies, humans from the Americas also meet or exceed the range of variation of Old World samples in intralimb indices, but not relative torso height or bi-iliac breadth, where African samples are longer-limbed and narrower. This is supported by a comparison of ranges for the samples (excluding extreme outliers), presented in Table 6.53.

One-way ANOVAs better describe the differences between these two hemispheres. Comparing the Old World to the New World as whole samples, by sex, demonstrates that females significantly differ between the hemispheres in certain respects: females in the Americas have significantly ($p < 0.05$) shorter lower limbs (absolutely and relative to torso

Table 6.53. Ranges and means of morphologies compared in Figures 6.13–6.16 for both hemispheres.

Hemisphere	MALES											
	Brachial index			Crural index			Relative torso height			Bi-iliac breadth		
	Min	Max	Mean	Min	Max	Mean	Min	Max	Mean	Min	Max	Mean
Americas	69.2	85.2	77.7	76.9	90.2	84.4	42.1	53.9	47.2	234	309	269.5
Europe & Africa	73.1	83.0	77.3	79.1	89.4	84.2	38.7	51.4	46.5	226	308	263.2
Hemisphere	FEMALES											
	Brachial index			Crural index			Relative torso height			Bi-iliac breadth		
	Min	Max	Mean	Min	Max	Mean	Min	Max	Mean	Min	Max	Mean
Americas	68.7	83.0	76.3	77.9	89.4	83.9	42.3	54.9	47.8	225	298	260.7
Europe & Africa	69.9	82.3	76.2	79.0	88.7	83.8	40.4	54.0	46.9	222	288	253.6

height as well as upper limb length) and wider bi-iliac breadths. New World males, on the other hand, have high brachial indices, absolutely shorter torsos and longer lower limbs (and thus relatively longer upper limbs and relative torso heights), wider bi-iliac breadths and higher mean body masses.

Of course, such a set of comparisons obscure the great amount of variation present in both hemispheres. One-way ANOVAs comparing morphologies among the regions, by sex, reveal a somewhat more complex concept of variation in Europe and Africa versus the Americas. Homogeneous subsets developed from Games-Howell post-hoc tests are provided in Tables 6.53 and 6.54 at the end of the chapter. Both males and females from the Central Arctic have significantly lower brachial indices than any other region in either hemisphere, though they are not significantly different from samples from high latitude groups in either the Americas or Europe in crural index. Interestingly, at the opposite end of the range for these indices, African regional means fail to differ in brachial and crural indices from many

of the regions in North and South America, and in all cases except one (male crural index), the Ayalán from Ecuador exhibit higher intralimb indices than equatorial African samples. In general, however, warmer regions from the Americas tend to have higher crural indices, though the brachial indices are more jumbled in comparing geography and climate with brachial index means.

As had been indicated by Figure 6.15, relative torso height, while following a clinal pattern in the Old World (and indeed is significantly different among the regions), reveals no such observable patterns in the Americas. Western Arctic males and females, for example, are not different in their relative sitting heights from those in California. It is worth noting that, in the Old World, the pattern in relative torso height is apparently related more strongly to the patterns in absolute torso height than to lower limb length (note that this dimension has the higher COVs of the two in Old World samples). An interesting contrast is that absolute torso height is statistically similar between arctic samples and African samples, even though this measure is not expected to covary with climatic factors.

Interlimb index, body mass and body breadth more strongly distinguish the two hemispheres. With the exception of European males, all Old World humans have shorter upper limbs relative to lower limbs when compared with the New World regions, except for the Central Arctic. This difference is subtle, but significant nonetheless. Samples from African regions also tend to be much narrower—especially among males—in bi-iliac breadth. With the exception of Ecuador, Guatemala, and the U.S. Southwest, humans in the New World regions tend to be wider in bi-iliac breadths, more similar to European samples than to African regions. This pattern is also present in body mass; on the whole, American samples are more massive than African samples, and equally as massive as European

samples. It is interesting that females fall into less distinguished homogeneous subsets for these latter morphologies than males; there is less variability in bi-iliac breadth among females compared with males.

These comparisons also help to elucidate some of the unusual patterns among New World groups. For example, samples from the Great Plains have intralimb indices similar to those found in tropical African groups; if these are indeed related to climate, this would suggest that the groups living on the Great Plains may have recently migrated from subtropical regions. This is additionally evident for U.S. Southwest samples in crural index, though their environment has been considerably warmer and drier than the Great Plains. It cannot be discounted, however, that these samples in the Southwest represent humans that migrated from more tropical regions. In fact, it may be that intralimb indices are better indicators of recent regional associations than any of the other morphologies under consideration. Certainly, body mass and bi-iliac breadth are more similar to higher-latitude European groups across the Americas, with lower body breadths occurring only in the most tropical regions.

How do the samples from the New World compare with other samples from the Old World? One area that would be interesting to compare with the Americas is Siberia, as it is where ancestral populations for the New World might have originated. Seven thousand year-old samples from the Lake Baikal region of Siberia¹⁸ (Lokomotiv, Raisovet, Shamanka, and Ust'Ida sites) have been measured by Dr. Jay Stock, who has shared data that may be used to calculate brachial and crural indices, body mass, and bi-iliac breadth. In comparing mean data for these Siberian samples with those reported in Figures 6.13-6.16 and Table 6.54,

¹⁸ No implication is made herein that these samples represent ancestors to any New World populations. The Lake Baikal groups postdate the latest initial migration dates to the Americas by at least 8000 years, and may not have been related at all to any groups that settled in the Americas.

these samples do not exhibit any extreme morphologies. The males from Lake Baikal have brachial indices higher than the average for the Americas and other Old World samples, but females generally have relatively lower brachial indices (male mean, 78.09; female mean, 75.41). Crural indices among the Siberians (male mean, 82.56; female mean, 82.37) are comparatively lower than mean indices for Europeans, Africans or New World populations, however. In these intralimb indices, it is apparent that the Siberians are most like Northern Europeans or the cool temperate regions of the Americas (e.g., the Western Plateau or Gran Chaco/Patagonia), with the exception of the male brachial indices. Comparisons of bi-iliac breadths (Siberian male mean, 261.53 mm; female mean, 260.13 mm) and body masses (Siberian male mean, 66.82 kg; female mean, 58.75 kg) support these associations. However, note that male New World samples, on average, are considerably wider than the Siberian males. It is noteworthy that the Siberian samples are not as wide-bodied as many North American samples, and certainly not as broad as the samples from the Central Arctic or Great Plains.

Together, these results indicate that, at least among these samples from Lake Baikal, the extreme morphology observed in the arctic of North America was not present in southern Siberia at 7000 yBP, though these skeletons do exhibit the lower crural indices observed in subarctic groups. As Lake Baikal was likely a cool temperate environment then, just as it is today, this is not surprising. Without Siberian samples from further north and east, it is not possible to assert if the more extreme cold adaptations were present as well during this time period, or how these Lake Baikal skeletons would relate to those samples from Beringia. Yet one important conclusion from these comparisons is the evidence that, at least among males, groups from North America are generally wider-bodied than even the Siberians. Indeed

contemporary male samples from the Americas have, on average, somewhat wider pelves (on average, 266 mm), despite living in more southern latitudes and much warmer climates. Perhaps this implies a retention of wider body morphologies among New World samples from ancestors, greater gene flow in the Old World among wider- and narrower-bodied groups, or less adaptive pressure in the Americas on this morphology.

Thus, the variation observed in the Americas *is* “considerable” in most morphologies, matching or exceeding those observed in select but widely dispersed regions from the Old World. Only bi-iliac breadth and relative torso height fail to reach the low values observed in central African regions, or lower limb length found in East Africa. Yet, despite this variation in the New World, there are less distinctive clinal patterns, especially in body size.

Table 6.54. Homogeneous subsets for male morphologies that significantly ($p < 0.05$) vary among regions in the Old and New World. Values indicated are regional means for the given morphology. These tables continue on the following pages. Old World regions are highlighted in **bold** type to allow for easier comparisons.

BRACHIAL INDEX	Subset for alpha = .05			CRURAL INDEX	Subset for alpha = .05	
	1	2	3		1	2
Central Arctic	72.64			Central Arctic	81.00	
Western Arctic		75.44		Northern Europe	81.40	
Northern Europe		75.57		Western Arctic	81.64	
Southern Europe		75.65		Pacific Northwest	82.84	82.84
Pacific Northwest		77.43	77.43	Western Plateau	83.30	83.30
Guatemala		77.55	77.55	Southern Europe	83.48	83.48
Southeastern U.S.		77.73	77.73	Gran Chaco/Patagonia		84.49
Western Plateau		77.91	77.91	Southeastern U.S.		84.54
Peru		77.98	77.98	Tierra del Fuego		84.65
U.S. Southwest		78.04	78.04	California		84.78
Prairie & Eastern Woodlands		78.28	78.28	Ecuador		84.79
California		78.28	78.28	Guatemala		85.06
South Texas		78.54	78.54	Prairie & Eastern Woodlands		85.07
Great Basin		78.90	78.90	South Texas		85.13
North Africa		78.90	78.90	Great Basin		85.16
Great Plains		79.16	79.16	North Africa		85.21
East Africa		79.32	79.32	West Africa		85.21
Tierra del Fuego			79.63	Great Plains		85.26
Gran Chaco/Patagonia			79.83	Peru		85.59
West Africa			79.86	U.S. Southwest		85.66
Ecuador			80.14	East Africa		86.28

Table 6.54. (continued)

LOWER LIMB LENGTH	Subset for alpha = .05	
	1	2
Pacific Northwest	754.39	
Western Arctic	759.72	
Peru	762.03	
Tierra del Fuego	775.94	
Ecuador	780.00	
Central Arctic	780.19	
Western Plateau	781.02	
Great Basin	787.02	
U.S. Southwest	787.27	
Guatemala	797.80	797.80
Gran Chaco/Patagonia	806.80	806.80
Southeastern U.S.	809.94	809.94
Northern Europe	810.24	810.24
California	810.40	810.40
West Africa	812.66	812.66
Great Plains		821.12
South Texas		827.45
North Africa		827.67
Prairie & Eastern Woodlands		828.14
Southern Europe		839.15
East Africa		860.93

ABSOLUTE TORSO HEIGHT	Subset for alpha = .05	
	1	2
Central Arctic	357.70	
East Africa	360.81	
Western Arctic	362.61	
Western Plateau	367.02	367.02
North Africa	367.39	367.39
Ecuador	368.28	368.28
U.S. Southwest	368.83	368.83
Peru	373.82	373.82
Pacific Northwest	374.65	374.65
Southeastern U.S.	380.35	380.35
California	381.53	381.53
South Texas	382.39	382.39
Prairie & Eastern Woodlands		386.67
Great Basin		387.76
Great Plains		388.89
Southern Europe		394.01
Northern Europe		395.51

RELATIVE TORSO HEIGHT	Subset for alpha = .05		
	1	2	3
East Africa	41.35		
North Africa	44.78		
South Texas	45.17	45.17	
Central Arctic		45.99	
Prairie & Eastern Woodlands		46.66	46.66
Western Plateau		46.88	46.88
U.S. Southwest		46.93	46.93
Great Plains		46.93	46.93
Southeastern U.S.		46.98	46.98
Ecuador		47.24	47.24
Southern Europe		47.41	47.41
California		47.52	47.52
Western Arctic		47.64	47.64
Northern Europe		48.85	48.85
Peru		49.15	49.15
Pacific Northwest			49.90
Great Basin			50.00

Table 6.54. (continued)

RELATIVE UPPER LIMB LENGTH/TORSO HEIGHT	Subset for alpha = .05	
	1	2
Great Basin	141.19	
Peru	143.12	
Northern Europe	144.68	
Southern Europe	144.86	
Pacific Northwest	145.11	
California	146.80	
Ecuador	146.83	
Central Arctic	147.94	
Western Arctic	148.42	
Great Plains	148.71	
U.S. Southwest	149.48	
Southeastern U.S.	149.73	
Prairie & Eastern Woodlands	150.30	
Western Plateau	150.50	
North Africa	153.07	153.07
South Texas	153.53	153.53
East Africa		164.16

INTERLIMB INDEX	Subset for alpha = .05	
	1	2
Central Arctic	67.81	
North Africa	68.09	
East Africa	68.32	
Southern Europe	68.52	
West Africa	68.55	
California	69.81	69.81
Great Plains	69.82	69.82
South Texas	69.87	69.87
Peru	70.05	70.05
U.S. Southwest	70.07	70.07
Prairie & Eastern Woodlands	70.08	70.08
Northern Europe	70.09	70.09
Southeastern U.S.	70.13	70.13
Guatemala	70.43	70.43
Western Plateau	70.47	70.47
Gran Chaco/Patagonia	70.49	70.49
Great Basin	70.63	70.63
Western Arctic	70.65	70.65
Ecuador	70.70	70.70
Tierra del Fuego		71.17
Pacific Northwest		72.55

Table 6.54. (continued)

BI-ILIAC BREADTH	Subset for alpha = .05		BODY MASS	Subset for alpha = .05	
	1	2		1	2
West Africa	230.29		West Africa	55.64	
East Africa	241.67		East Africa	57.47	
Ecuador	245.00		North Africa	59.01	
North Africa	254.70	254.70	U.S. Southwest	61.22	
Gran Chaco/Patagonia		262.19	Ecuador	62.43	
U.S. Southwest		265.81	Western Plateau	64.60	64.60
Great Basin		267.25	Southeastern U.S.	64.63	64.63
Western Plateau		267.83	Great Basin	64.67	64.67
Southeastern U.S.		267.98	Guatemala	64.87	64.87
Western Arctic		269.96	South Texas		66.16
Peru		270.04	Pacific Northwest		66.46
Pacific Northwest		270.68	Peru		66.59
Tierra del Fuego		271.54	Tierra del Fuego		66.72
South Texas		272.16	Prairie & Eastern Woodlands		66.83
Guatemala		272.33	Northern Europe		67.17
Central Arctic		273.16	California		67.20
Prairie & Eastern Woodlands		273.35	Western Arctic		67.89
California		273.87	Gran Chaco/Patagonia		68.09
Southern Europe		278.00	Great Plains		69.03
Northern Europe		279.29	Southern Europe		70.08
Great Plains		280.96	Central Arctic		72.72

Table 6.55. Homogeneous subsets for female morphologies that significantly ($p < 0.05$) vary among regions in the Old and New World. Values indicated are regional means for the given morphology. These tables continue on the following pages.

BRACHIAL INDEX	Subset for alpha = .05			CRURAL INDEX	Subset for alpha = .05	
	1	2	3		1	2
Central Arctic	71.41			Central Arctic	80.97	
Western Arctic		73.32		Western Arctic	81.19	
Southern Europe		74.14		Tierra del Fuego	81.90	81.90
Northern Europe		74.81		Northern Europe	82.10	82.10
Tierra del Fuego		75.60		Pacific Northwest	82.39	82.39
Pacific Northwest		75.62		Western Plateau	82.96	82.96
Southeastern U.S.		76.14	76.14	Southern Europe	83.11	83.11
Great Basin		76.18	76.18	Southeastern U.S.	83.93	83.93
Gran Chaco/Patagonia		76.30	76.30	Great Basin	84.12	84.12
California			76.44	Prairie & Eastern Woodlands	84.27	84.27
U.S. Southwest			76.87	California	84.32	84.32
Prairie & Eastern Woodlands			77.15	West Africa	84.38	84.38
West Africa			77.22	North Africa	84.66	84.66
Peru			77.73	U.S. Southwest	84.70	84.70
South Texas			77.80	Great Plains	84.80	84.80
Western Plateau			78.12	South Texas	85.10	85.10
Great Plains			78.18	Guatemala	85.19	85.19
North Africa			78.20	Gran Chaco/Patagonia		85.67
East Africa			78.47	Peru		86.05
Guatemala			78.83	East Africa		86.09
Ecuador			79.37	Ecuador		86.26

Table 6.55. (continued)

LOWER LIMB LENGTH	Subset for alpha = .05	
	1	2
Tierra del Fuego	699.32	
Peru	701.67	
Ecuador	702.90	
Pacific Northwest	705.30	
Western Arctic	705.66	
Guatemala	710.08	
Great Basin	723.20	723.20
West Africa	723.38	723.38
U.S. Southwest	727.43	727.43
Western Plateau	732.24	732.24
Central Arctic	734.42	734.42
California	750.59	750.59
Great Plains	753.98	753.98
Northern Europe	754.46	754.46
Southeastern U.S.	755.40	755.40
Southern Europe	755.48	755.48
Gran Chaco/Patagonia	764.16	764.16
North Africa	764.87	764.87
South Texas	770.54	770.54
Prairie & Eastern Woodlands	772.53	772.53
East Africa		790.03

ABSOLUTE TORSO HEIGHT	Subset for alpha = .05	
	1	2
Guatemala	330.43	
Peru	337.33	337.33
Western Plateau	337.34	337.34
East Africa	341.17	341.17
Ecuador	343.04	343.04
North Africa	343.81	343.81
Western Arctic	344.54	344.54
Central Arctic	347.53	347.53
U.S. Southwest	348.49	348.49
Great Basin	356.30	356.30
Pacific Northwest	357.04	357.04
Southern Europe	358.62	358.62
Great Plains	359.38	359.38
Southeastern U.S.	359.73	359.73
California	360.39	360.39
South Texas	362.91	362.91
Prairie & Eastern Woodlands	365.16	365.16
Northern Europe		375.68

RELATIVE TORSO HEIGHT	Subset for alpha = .05	
	1	2
East Africa	42.87	
North Africa	45.53	45.53
Western Plateau	46.64	46.64
South Texas	47.02	47.02
Guatemala	47.17	47.17
Central Arctic	47.30	47.30
Prairie & Eastern Woodlands	47.41	47.41
Southeastern U.S.	47.57	47.57
Great Plains	47.78	47.78
U.S. Southwest	47.85	47.85
Southern Europe	47.93	47.93
Peru	48.15	48.15
California	48.51	48.51
Western Arctic	48.62	48.62
Ecuador	48.87	48.87
Great Basin		50.03
Pacific Northwest		50.28
Northern Europe		50.34

Table 6.55. (continued)

RELATIVE UPPER LIMB LENGTH/TORSO HEIGHT	Subset for alpha = .05	
	1	2
Northern Europe	136.12	
Great Basin	140.29	140.29
Pacific Northwest	140.53	140.53
Southern Europe	141.11	141.11
Ecuador	142.98	142.98
California	143.05	143.05
Central Arctic	143.18	143.18
Peru	143.23	143.23
Western Arctic	143.66	143.66
U.S. Southwest	145.26	145.26
Great Plains	146.61	146.61
South Texas	146.84	146.84
Southeastern U.S.	146.90	146.90
Prairie & Eastern Woodlands	148.17	148.17
North Africa	148.76	148.76
Guatemala	150.28	150.28
Western Plateau	151.69	151.69
East Africa		159.64

INTERLIMB INDEX	Subset for alpha = .05	
	1	2
North Africa	66.99	
Central Arctic	67.01	
West Africa	67.44	67.44
East Africa	67.96	67.96
Southern Europe	68.21	68.21
Northern Europe	68.33	68.33
California	69.16	69.16
South Texas	69.28	69.28
Gran Chaco/Patagonia	69.48	69.48
Peru	69.51	69.51
U.S. Southwest	69.75	69.75
Western Arctic	69.75	69.75
Southeastern U.S.	69.90	69.90
Ecuador	69.96	69.96
Prairie & Eastern Woodlands	69.97	69.97
Guatemala	69.99	69.99
Great Plains	70.06	70.06
Western Plateau	70.37	70.37
Great Basin	70.71	70.71
Pacific Northwest	70.91	70.91
Tierra del Fuego		72.07

Table 6.55. (continued)

BI-ILIAC BREADTH	Subset for alpha = .05		BODY MASS	Subset for alpha = .05	
	1	2		1	2
West Africa	232.43		Ecuador	50.39	
East Africa	236.11	236.11	U.S. Southwest	50.73	
Ecuador	243.17	243.17	Tierra del Fuego	51.64	
North Africa	245.04	245.04	West Africa	51.66	
Guatemala	251.00	251.00	Guatemala	51.73	
Western Plateau	255.75	255.75	East Africa	53.18	53.18
Tierra del Fuego	256.93	256.93	North Africa	53.37	53.37
Pacific Northwest	256.98	256.98	Southeastern U.S.	54.38	54.38
Peru	258.33	258.33	Great Basin	54.59	54.59
U.S. Southwest	258.64	258.64	Peru	54.97	54.97
Southeastern U.S.	259.80	259.80	South Texas	55.14	55.14
Gran Chaco/Patagonia	261.20	261.20	Pacific Northwest	55.68	55.68
Western Arctic	261.73	261.73	California	56.34	56.34
Great Basin	262.00	262.00	Prairie & Eastern Woodlands	57.54	57.54
South Texas	262.46	262.46	Western Arctic	57.63	57.63
Southern Europe	263.69	263.69	Western Plateau	57.71	57.71
Prairie & Eastern Woodlands	264.45	264.45	Gran Chaco/Patagonia	57.78	57.78
California	265.21	265.21	Great Plains	58.63	58.63
Northern Europe	265.26	265.26	Northern Europe	58.76	58.76
Great Plains		267.79	Southern Europe	59.12	59.12
Central Arctic		268.92	Central Arctic		63.14

Chapter 7

DISCUSSION & CONCLUSION

“ELIMINATE ALL OTHER FACTORS, AND THE ONE WHICH REMAINS MUST BE THE TRUTH.”

- Sherlock Holmes, The Sign of Four

7.1: Hypotheses revisited: unfolding the evidence

This dissertation set out to determine the patterns of morphological variation among humans from the New World and the relative effects of climatic factors and subsistence on that morphological variation. Clearly, the results of the analyses argue for much morphological variation throughout the Holocene in North America, and a correlation between these morphologies and both climate and subsistence. By reviewing the hypotheses set out in Chapter 3, the outstanding task that this chapter will attempt to complete is the disentanglement of the effects of these factors. An overview of significant results in relation to these predictions must be presented first. In Chapters 5 and 6, there are a plethora of interesting findings reported, but many of these are relatively minor in the context of the overall hypotheses being tested. In the interest of brevity, this discussion will focus on results directly applicable to the testing of the three groups of specific hypotheses presented in Chapter 3, related to general patterns of morphological variation, and the relationship of variation in morphology to climate, geography and subsistence.

Following these conclusions, some of the broader topics introduced in the first three chapters of this dissertation are readdressed. As argued throughout these initial chapters, an understanding of morphological variation is useful for elucidating unresolved issues regarding population relationships and movements. This chapter, then, represents the conceptual setting wherein inductive and deductive reasoning meet: the induced results and

conclusions from the testing of the hypotheses are applied to the broader models deduced by previous research.

Before proceeding to review the evidence, some caveats introduced previously should be reiterated. First, correlations between factors and morphological variation should never be interpreted as being indicative of a direct relationship between the factors. Although the direct influence of an environmental factor may be the primary selection pressure on a given morphology, a number of mechanisms are possible to mediate the change, both *in vivo* and across multiple generations (as reviewed in Chapter 3). Related to this is the fact that any correlation could reflect the effects of a third factor not under consideration. Second, recall that “multiple solutions for biological needs are the general rule in evolution” (Mayr, 1956). Climatic factors or subsistence factors, for example, never wholly affect any aspect of an organism; the phenotype of humans is a balance among a number of factors, extrinsic as well as intrinsic. Indeed, much of the observed morphological variation is as likely the result of additive adaptations (e.g., physiological and morphological responses to climatic factors) as they are of exclusive adaptations and mechanisms.

7.1.1: Group 1: Morphological variation in the Americas

Cranial and postcranial morphology, as predicted, significantly vary among regions and through time across the New World. There is no New World human “homotype.” Indeed, based on the comparison of the earliest skeletons from the Holocene of North America, it is not possible to document a New World “homotype” at any observable time period. If there were any consistent message to be gleaned about humans in the Americas, it is clearly that *morphological variation has been the rule*. The range of variation, arguably, has increased over time, but at no time were humans identical. Not all morphologies vary equally,

however, and there are a number of interesting distinctions among these that might further argue for varying amounts of developmental plasticity. There are also distinctions between males and females in the variation of dimensions and proportions.

Males and females do not have the same patterns of variation in cranial shape and proportions, but each sex exhibits some continuity among samples in relation to temporal changes. Nasal index has the highest amount of variation of any cranial dimension examined, and, surprisingly, this is driven by greater variance in nasal height. This is unexpected, as previous studies (e.g., Franciscus and Long, 1991) have suggested that variation in breadth contributes more to differences among groups' nasal indices. Inexplicably, females have significantly higher nasal indices—relatively broader nasal apertures—than males throughout all time periods. Similar to the pattern for nasal index, upper facial height—while less variable than either nasal dimension—contributes significantly more to variation in facial index than bi-zygomatic breadth. This is also contrary to expectations and previous studies, with the exception of Gugliemino-Matessi et al. (1979), who indicated facial height as highly, negatively correlating with climatic factors (see Table 5 in their paper, page 558). Neither facial nor nasal indices exhibit systematic change among time periods, however, unlike cranial index, which significantly increases over time. This is a trend paralleling observations in overall changes in cranial shape worldwide; globally, humans generally have rounder crania in more recent time periods. Interestingly, there is an implication that the contribution of cranial dimensions to shape changes are not the same in males and females: males' head shape changes are more related to variation in breadth (as predicted), but females do not show any difference in the relative contribution of calvaria breadth or length. This, in turn, may suggest differences in

mechanisms by which cranial shape changed for males and for females. As predicted, there is significant sexual dimorphism in cranial index, but only in the last 1500 yBP, and, interestingly, with females generally possessing rounder crania than males. In contrast, and unexpectedly, males in the earliest temporal periods have significantly relatively broader faces, and sexual dimorphism in facial index disappears in more recent millennia. Perhaps these are related to changes in masticatory behavior, or are related to sampling. I will return to the mechanisms of this change after discussing cranial variation in relation to climate and to subsistence. Shape changes in the crania are not correlated with changes in size, however. There is an increase in cranial module in the mid-Holocene, but cranial module is generally lower in both the first millennia and most recent millennia of the Holocene. As expected, males have significantly larger crania—a reflection of body size—across all times.

Indeed, integration in these morphologies of the skull is very low. There is some correlation ($r < 0.3$) in the dimensions of the face and their indices, a result that matches expectations based on development of the face (Enlow and Hans, 1996). As multiple developmental structures (e.g., maxillary prominences, nasal placodes, etc.) are involved in the development of the face, however, and as there are different relationships of facial shape and nasal aperture shape to environmental factors (reviewed below), it is not surprising that the similarity of these dimensions is low. There may be a complexity to this relationship that cannot be revealed by examining two-dimensional relationships, however; differences in prognathism and nasal projection are not examined in this dissertation, though these morphologies also vary considerably among humans. More importantly, there is little correlation between the shape and size of the neurocrania and the shape of the face and nasal aperture. Developmentally, these are separate complexes, and so this distinction is not

unexpected. Also, these differences in the correspondence of indices probably relate to the differences in the variance of contributory dimensions—breadth differences contributing more to variation in the neurocrania versus height dimensions in the face.

Like the proportions of the crania, the shape and proportions of the postcrania exhibit great variation among the humans of the New World, and have greater sexual dimorphism but fewer temporal trends. As predicted, crural index and interlimb index are not sexually dimorphic, while all other proportions and dimensions of the postcrania are significantly different between males and females. Interestingly, females have significantly higher relative torso heights than males in all time periods, though this dimorphism decreases in more recent temporal periods, while males have higher values for the other indices and all body size-related dimensions. The reasons for these differences are uncertain, though they may simply be sexually dimorphic genetically, or could relate to longer periods of primary growth in males, different effects of hormone concentrations on bone growth, or metabolic differences between the sexes. Curiously, all shape indices demonstrate increased sexual dimorphism in the middle Holocene, while body sizes show *decreased* dimorphism in the middle Holocene. This is probably attributable to sample and regional biases. On the whole, there are no distinctive temporal trends in changes among these indices, except for the relative length of the upper limb to the torso, which decreases over time. This trend, however, is coincidental with the inclusion of arctic samples that have relatively short limbs relative to torso height, and so the trend is most likely an artifact of this sample bias. This is corroborated by examining apparent temporal trends in bi-iliac breadth. With the inclusion of these high latitude samples in more recent time periods, mean bi-iliac breadths increase substantially. Yet, it is notable that no similar changes occur in the mean intralimb indices

through time, despite the inclusion of high-latitude samples in the last 2500 years. This implies that samples with low intralimb indices—unquestionably associated with populations from the arctic—were also present among the earliest samples, or that a disproportionate predominance of samples with high intralimb indices in more recent time periods counteracts the inclusion of the arctic samples. Examining the maps for brachial and crural indices in Appendix VI, the latter appears to be the reason for this lack of temporal change in mean intralimb indices, especially for males.

The foregoing supports the hypothesis that variation in intralimb proportions is influenced more by distal elements, and this mirrors previously reported results (Holliday and Ruff, 2001). However, the variance in the lower limb and in torso height are not significantly different, and relative sitting height is *not* influenced by positive scaling in the lower limb, contrary to the secular trends reported by Jantz and Jantz (1999). There is positive scaling in the intralimb indices for both sexes, and slight negative scaling in male interlimb index; forearms and legs are disproportionately longer in individuals with longer arms and thighs, and males with longer lower limbs tend to have relatively shorter upper limbs. Notably, lower limb length, overall, scales isometrically with absolute torso height, though tibia length scales positively. This means that there is a tendency for individuals with longer torsos to have disproportionately longer tibiae—a result reported previously (Meadows and Jantz, 1995; Jantz and Jantz, 1999)—but femoral lengths scale *isometrically* with torso height. Thus, the lack of non-isometric scaling in the lower limb relative to the torso argues that, while the tibiae in taller individuals tend to be slightly disproportionately longer, this does not significantly affect relative torso height. A brief assessment of the correspondence of crural index with stature (an implied connection) yields a correlation

between these in the POD ($r = 0.21$), which, while statistically significant, is quite low and argues against a relationship between taller individuals and higher crural indices across the total sample. Even within samples, this correlation remains as low (e.g., Indian Knoll, $r = 0.22$), if not lower (e.g., Alutiiq, $r = 0.03$).

Most of the indices of the postcrania vary independently of each other and of cranial proportions. Only the intralimb indices—brachial and crural index—have a high, significant correlation ($r > 0.5$ in both sexes). In addition, contrary to the hypotheses, there is little covariance between cranial proportions and postcranial proportions. Intralimb indices have a weak, positive correspondence with cranial and nasal indices (though note that these do not correspond with each other). A moderate correlation ($r \approx 0.3$) between cranial module and bi-iliac breadth is attributable to their correspondence with body size. These patterns are inconsistent among samples, however, suggesting that, while these morphologies correspond, there is a great amount of independence in their variance in relation to intrinsic and extrinsic factors. It also argues that the similarity of patterns observed in the crania and the postcrania by other authors (e.g., Newman, 1953) have been broadly coincidental in relation to the same selective factors. Most importantly, these results indicate that cranial and postcranial morphologies experience considerably different amounts and rates of response to external factors, differential environmental sensitivity (i.e., plasticity), or both. This is further explored in relation to the results for environmental factors in the following subsections.

In summary, some morphologies have greater variance, and therefore might be interpreted to have higher amounts of developmental plasticity. As expected, these are morphologies potentially related to ecogeographic patterning: nasal aperture and the relative lengths of distal limb elements, for instance. Most of the proportions of the skeleton vary

independently, which further indicates that there are different degrees of response to environmental factors possible, or responses to different combinations of factors. It is curious that the most robust covariation of morphologies is between the two intralimb indices. This may indicate similar responses in the forearm and leg lengths to environmental factors, the effects of serial homology and genetic constraint in the patterning of limbs (vis-à-vis Halgrímsson et al., 2002), or, more likely, a combination of both. It may be that genetic constraint dictates a maximum growth potential for the lengths of distal limb segments (relative to proximal segments), and environmental factors further modulate this. That is, as inferred by the reported limb lengths of juveniles skeletons from the arctic (e.g., Y'Edynak, 1978), environmental factors affect a genetically controlled range of variation for morphology, potentially early in ontogeny. Readers should keep this in mind when considering the evidence reviewed below regarding climatic and subsistence effects on the skeleton.

Some morphological characteristics are as varied in the New World as they are in the Old World, as predicted in the hypotheses; but many are not. Granted, this may only be examined among the postcranial dimensions available for comparison between the POD and COD: intralimb indices, interlimb index, bi-iliac breadth, relative and absolute length of the torso, and body mass. Still, these are pertinent variables in relation to morphological differences relating to climate and to subsistence. As noted at the end of Chapter 6, most of these have ranges of variation that are equal or greater among humans from the Americas in comparison with Europeans and Africans. Critically, relative height of the torso (to both upper and lower limbs), body breadth, and body mass are *less* variable in the New World. In these morphologies, East African populations have lower values than any observed in the

Americas. Yet, the fact that the POD samples generally meet or exceed the body breadth and body mass of North Africans strongly argues for a great amount of clinal morphological variation in these dimensions in the Americas. It is important to note that only one true tropical population is used in this dissertation—the Ayalán from Ecuador—and more measurements from other tropical archaeological populations may reveal even more extreme morphologies in the equatorial regions of the New World. Note that, as these few Ayalán individuals did not have lower limbs as long as those found in East Africa, their environment—coastal seasonal rainforest—was considerably different from that experienced by the Nilotic peoples of Africa. I will comment further on the significance of this finding on rates of human adaptation in the following sections reviewing climatic and subsistence evidence.

7.1.2: Group 2: Morphological variation in relation to climate and geography

Given the many results reported for morphological variation in relation to climatic factors, there are potentially many exceptions to the general patterns reported in Tables 6.15.1 and 6.15.2 (pages 294 and 295), as well as the summary at the end of section 6.3.1 (beginning on page 319). However, just as Mayr (1956) argued that the general empirical evidence is important to understanding the correspondence of morphology with geographic location, I contend that the general patterns are the most informative concerning the relationship of morphological variation with climatic variables. Exceptions to these are also interesting, and, in some cases, highly informative about population movements and relationships.

In the overall sample, as well as samples divided by temporal period and by region, there are correlations between morphologies and climatic factors. In general, these are higher and

more consistent among males (see Appendix VI). Females may be less responsive to climatic factors or variables related to variation in climate, especially in body breadth.

Among proportions and size of the skull, the most consistent correlations with climate are in cranial index, cranial module, and nasal index. These results generally indicate that populations in locations with warmer overall climates have rounder crania (*contra* expectations) and relatively wider nasal apertures (in accordance with hypotheses), and that individuals have larger crania in wetter climates (contrary to predictions). Also against hypotheses, relative facial breadth has no correspondence with variation in climatic factors, though it does have a general correspondence with scaled longitude (Table 6.14). This difference between nasal and facial indices in variation among samples and correspondence with climatic factors argues for greater independence in these two morphologies, corroborating the evidence from examining covariance in these two indices. Nasal indices, though, do not significantly correlate with temperature until after 2500 yBP, and, in regional analyses, only significantly correlate with climatic factors within the arctic (where colder temperatures are associated with relatively narrower nasal apertures). This latter conclusion likely is an effect of constrained climatic variation in many of the regional analyses. It should also be noted that, contrary to hypotheses, variation in nasal indices does not correspond with variation in the general “wetness” of environments; narrower noses are not necessarily found in drier climates. Across all regions through time, as well as within regions, there is no consistent relationship between cranial module and temperatures, though samples with larger crania in the arctic tend to cause a biasing influence on the relationship of cranial size with temperature. In point of fact, the arctic samples significantly affect the relationship of cranial morphology with climatic factors, inflating correlations between

temperature and morphological variation—a conclusion arrived at as well by Havarti and Weaver (2006). When temperatures do significantly correlate with variation in cranial morphology, it is noteworthy that mean annual temperature generally has more consistent and higher coefficient values than temperature extremes, contrary to hypothesized patterns.

Postcranial dimensions, in contrast, demonstrate stronger covariation with climatic factors, as predicted in the hypotheses. Both brachial index and crural index have high and consistent correlations with climatic variables. As expected, higher intralimb indices are found in samples from locations with warmer and drier overall climates. Note, however, that it is not until 4000 yBP that variation in either index correlates significantly with climatic factors, and it is only crural index among females that has a noteworthy covariance with climate between 4000 and 2500 yBP. In fact, it is not until the last 1500 years that brachial and crural indices both covary similarly with climatic factors. Any covariance between these proportions among samples prior to that time period cannot be attributed to similar reactions to climate or accessory variables. Indeed brachial and crural indices rarely vary with climate in any regional analyses, but, again, this may be due to restricted climatic ranges within regions. Recall that there is evidence that subtle variation in crural index in the U.S. Southwest may be related to population history. It is possible that the muted correlations in some time periods are the result of continued population movement prior to the advent of agriculture and more sedentary lifestyles. Yet, despite these inconsistencies, it is important to note that, without exception¹, by 1500 yBP, the total available sample, with and without arctic samples included, demonstrate a significant, positive relationship between intralimb indices, high MATs and MXTs, and low precipitation. Related to crural index, after 4000

¹ The rather inexplicable reversal of climatic correlation in subarctic samples from the last 500 years, as pointed out in the Results, is almost certainly the result of the inclusion of the Great Plains skeletons, which, as is discussed below, were unquestionably recent migrants to the region.

yBP, there is a pattern in which individuals in warmer and drier climates have longer lower limbs (possibly due to the positive scaling of the length of the tibia relative to the femur), though not consistently. Longer lower limb lengths are seldom disproportionate to the height of the torso, the absolute height of which also tends to be higher in overall warmer and drier climates. In fact, as implied by the scaling results, relative torso height does not vary often in relation to climatic factors because its component measurements appear to respond to intrinsic and extrinsic factors isometrically. This result is strong contrary evidence for the hypothesized relative decrease in torso height in warmer climates, especially when only subarctic samples are considered. Unexpectedly, humans tend to be shorter in cooler and wetter subarctic climates. However, including the arctic samples, the pattern in stature matches the climatic correlations for two of its component measurements: lower limb length and absolute torso height. As an aside, shorter statures in wetter environments have been proposed previously as one morphological means of improving heat dissipation (and heat production minimization) in climates that reduce the effectiveness of other mechanisms for heat loss (such as sweating). As reviewed below, subsistence modes and geographic distributions of populations have a confounding effect on this apparent reversal in the distribution of statures. In contrast, robust positive evidence exists for variation in body mass in relation to climatic factors. From the earliest temporal periods considered, samples from cooler and, occasionally, drier climates had higher mean body masses in both sexes. This morphology matches predictions in that it also correlates more with extreme temperatures: populations experiencing cooler summers have higher body masses. Upper body width, which may relate to body mass, has no relationship with climate. Given the imprecise relationship of this derived morphology to thoracic shape, however, it is possible that, with a

better model by which to relate this skeletal dimension to living morphology, variation in upper body width in relation to climatic factors may yet be uncovered; after all, it does weakly relate to altitude (Weinstein, 2006). Interestingly, although bi-iliac breadth *is* related to body mass (Ruff, 1994a; Ruff et al., 1997; Auerbach and Ruff, 2004), it does not demonstrate consistent relationships with climatic factors and has lower correlations than body mass when it does. Within most regions, and across some temporal periods, males tend to have narrower pelves in locations with warmer summers, but bi-iliac breadth largely varies independently of climatic factors among females.

This last set of observations is particularly interesting, especially when placed into context with variation over time in bi-iliac breadth and differences in the dimension's New World range compared to Europe and Africa. Ruff (1994a) suggested that bi-iliac breadths among samples from more recent time periods in the Americas are generally wide compared with the Old World (i.e., there is a reduced cline), and further argued that 1) this is evidence for "cold filtering" in the founding populations of the New World, and 2) the length of time for changes in the pelvis in relation to climate is relatively slow compared with potential changes in limb proportions. Recall, as well, that pelvic breadth is a crucial dimension in relating overall body shape to thermoregulation. In the more recent millennia of the Americas, there is a clear cline in pelvic breadth from the arctic to the tropics, which is stronger among males. Pelvic breadths are narrower among the Ecuadorian Ayalán than those reported among archaeological samples from Egypt and the Sudan. Therefore, some adaptation has been occurring in the New World, with some correspondence to climatic factors (namely temperature). Yet Ruff's (1994a) observation, based on a more restricted New World sample, holds up: populations in the New World are, on the whole, wide-bodied.

Assuming that the ancestors of these various samples were generally wide-bodied, and the existence of as great a range of morphological variation in the Americas as in Europe and Africa for intralimb indices, then there is support for the assertion that bi-iliac breadths are more constrained in their variation in relation to climatic factors than limb proportions. This, of course, assumes that these morphologies respond to the same factors.

One constraint on pelvic morphology, also pointed out by Ruff (1991, 1993), is the size and shape of the birth canal in females. The general lack of correspondence between climatic factors and female bi-iliac breadth—indeed, the lower range of variation in pelvic breadth among females in the New World—would suggest that this constraint has played an active role in restricting climatic adaptations among females. Also, locomotive effects must be considered; the biomechanical advantage of the gluteal muscles may be affected by changes in the orientation and shape of the iliac blades, and so this morphology may be further constrained due to restrictions related to mobility. Alternatively, one might argue that the selective pressures did not exist for New World populations to develop the very narrow bodies found in Africa, mostly due to cultural buffering. This is possible, but not testable and probabilistically unlikely. Even as physiologists argued with morphologists about the validity of proposed mechanisms behind Bergmann's Rule, there was little argument that cultural buffering could attenuate the effects of heat stress on the body. Vasodilation and sweating are only a viable mechanism until dehydration becomes a mortal problem. As humans moved into tropical environments of the New World, assuming that their ancestors were wide-bodied, there would have been a selective pressure to develop physiologies and morphologies more conducive to heat dissipation. The fact that neither Ecuadorian nor Peruvian samples considered here (nor those New World tropical groups reviewed by Ruff)

have very narrow pelvises on par with Africans would therefore argue that the rate of change in this dimension is limited.

This all assumes that the ancestors of New World populations were wide-bodied. Is there evidence for “cold filtering” in these ancestors? The earliest measurable bi-iliac breadths from the POD—Spirit Cave and Kennewick—are broad by any standard, especially for males². As their other morphologies, however, do not place these individuals within an arctic range of morphologies—especially in limb proportions—it cannot be argued that these 9000 year-old skeletons represent an extreme climatic adaptation observed in more recent arctic groups. Yet they do retain wide bodies and, including Horn Shelter and Wizards Beach but excluding Spirit Cave, moderately high body masses³. Based on their other morphologies, though, their wide bodies are exceptional, and definitely would support the existence of wide-bodied ancestors for these skeletons. Whether this is because these predecessors spent extensive periods of time in Beringia prior to migrating south, or because the ultimate ancestral population(s) of the Americas was wide-bodied in general (perhaps due to living in cooler environments because of colder climates globally in association with ice ages), cannot be asserted at this point. Note, though, that some seafaring populations (such as the Lau; see Eveleth and Tanner, 1976) also tend to have wider bodies, though the causes for this morphology are uncertain and not universally found among seafaring populations (e.g., the Lufa also reported by Eveleth and Tanner, 1976). Further implications for the

² Their bi-iliac breadths are wider, in fact, than the mean breadths for all samples in the POD, EOD or COD, with the exception of the Great Plains groups.

³ Yet, within a millennium of these skeletons, the population burying their dead in Windover Pond had considerably narrower bodies and body masses more like Spirit Cave’s. Given the wide geographic dispersal among these skeletons, however, it is impossible to cite possible causes for this range of variation. Moreover, the males from Windover were still more than two centimeters wider, on average, than Eastern Africans. They were not even as narrow as North Africans, despite living in a warm temperate climate.

patterns of morphological variation in relation to climatic factors are considered below, as their interpretation requires a review of the subsistence evidence as well.

7.1.3: Group 3: Morphological variation in relation to subsistence

In general, proportions and body shape have less variability among subsistence groups than they do among samples occupying different climates. Some of the hypothesized relationships between morphological variation and subsistence groups are weakly supported by the results: agriculturalists do have a tendency for having rounder crania, for instance. However, as these individuals tend to live in warmer climates, it cannot be determined whether this morphological trend results from climate or masticatory effects. Taking climate into account, as predicted, nasal index and all postcranial proportions generally do not significantly differ among subsistence groups. Bi-iliac breadth, however, does vary among males practicing different forms of subsistence, though this is largely driven by differences between arctic hunter-gatherers and subarctic horticulturalists and agriculturalists. This assertion bears caution: as shown starkly in Table 6.34.3 (page 355), accounting for climate as a covariate in analyzing variation among subsistence groups removes a great amount of the explanatory power offered by subsistence groups. This is in part due to significant correlations between temperature—especially MXT—and subsistence. Yet, even though this correlation between subsistence groups and mean summer high temperatures is fairly low (see Table 6.3 on page 266), some morphologies significantly differing among subsistence groups are undoubtedly related to climatic factors (such as intralimb indices and variation in lower limb length).

In many instances, however, intralimb indices and other proportions do differ among subsistence groups, though not consistently. For example, within the Southeastern U.S., not

controlling for climate, agriculturalists and freshwater hunter-gatherers have significantly higher brachial indices than marine hunter-gatherers, whereas marine hunter-gatherers in the arctic have significantly higher brachial indices than freshwater hunter-gatherers. Though justified, controlling for climatic factors mutes the relationship of these phenotypic variations with subsistence. After all, it is without question that differences in subsistence can have profound effects on metabolism and nutrient availability, and therefore impact primary growth. As many of the morphologies observed in the adult skeleton are products of ontogeny, the available food supply and overall dietary stress will have profound effects on the ability of the skeleton to reach genetic potentials in growth. It is therefore conceivable that insults to skeletal development, though having a systemic effect, may differentially affect body proportions in subtle ways that cannot be easily assessed. In the analysis of differences among subsistence groups from the last millennium, it is indicated, for instance, that the tallest subsistence groups (and therefore the least potentially stressed in diet) also had the highest intralimb indices. This analysis included populations from multiple climates, though, as well as different population histories, and most of the tallest groups lived at lower latitudes in temperate North America (with the exception of Great Plains groups). It is important to note that in regional comparisons of groups living in similar climates but practicing different forms of subsistence, such as the Southeastern U.S. or California, there are few differences in intralimb indices or relative length of the limbs to torso height. Thus, based on the evidence available by examining archaeological skeletons, the argument that subsistence affects growth differently throughout the skeleton cannot be supported, though it cannot be outright refuted.

Some morphology does vary among subsistence groups exclusive of climatic factors. Most often, across time periods and regions, stature and body mass-related measurements significantly differ among subsistence groups. However, as noted in Chapter 6, these differences are not universal, so citing broad trends in morphological variation relative to subsistence is difficult. One of the more interesting results, however, is that agriculture did not universally lead to decreased statures among samples, and in fact resulted in increased statures in some regions (e.g., the Southeastern U.S.). As noted on pages 377 and 378, there is a trend for hunter-gatherers to be *shorter* than most horticulturalists and agriculturalists, with the exception of the broad-spectrum hunter-gatherers. This is contrary to some previous assessments of the effects of the introduction of agriculture (e.g., Cohen and Armelagos, 1984; Larsen, 1990; Steckel and Rose, 2002), which generally indicate a decrease in health, reflected in part by stature decreases. Of course, dietary stress would only occur if the food consumed became substantially reduced in nutritional diversity (which may not have occurred in much of North America), or if large concentrations of populations (e.g., state societies) depleted other food resources and increased reliance on a few crops. Very few of the agricultural samples employed herein, however, were representative of the highly stratified, intense agriculture observed in Mesoamerican and South American state societies. Yet, decreases in stature were not evident at Tikal (Haviland, 1967) until long after the Maya adopted agriculture, for example—even after they had developed a highly stratified society. Recall, as well, that Malina et al. (1983) reported no significant decrease in stature in the Oaxaca Valley, despite the development of a socially stratified society there. Other authors, as well, have reported stature increases with the adoption of agriculture, in part, perhaps, due to better regular nutrition and higher amounts of protein in the diet (e.g., Rose et al., 1984).

Therefore, the lack of consistent changes in stature with the introduction of agriculture may not be aberrant. Significantly, although body mass does vary among subsistence groups, it does not vary consistently. On the whole, as hypothesized, agriculturalists tend to have lower body masses, despite having generally tall statures, possibly in relation both to subsistence and climate. Male agriculturalists, it should be noted, also tend to have narrower pelvises (against expectations), though I consider this to be largely an artifact of the warm climates in which most of the agriculturalists lived.

Perhaps, then, the secular trends in stature observed in other samples are not the direct result of the adoption of agriculture, but instead are caused by secondary effects *associated* with agriculture. Some of these related factors include increased instances of communicable and parasitic disease with higher population densities, higher psychological and social stress, and, in highly socially stratified cultures, nutritional deprivation in the lowest social castes. Future analyses including samples from many socially stratified societies with different densities and diets, as well as data from strontium isotopes, would help to clarify the relative effects of these associated factors on stature.

Another significant implication of the variation in body proportions and size is that the differences among subsistence groups are always more pronounced in comparisons among males than among females. Through time, females demonstrate less overall variation in stature or body mass; often these morphologies do not significantly vary among females from different subsistence groups at all. This supports the concept of female “buffering.” The mechanisms for this remain unknown, but the pattern exists nonetheless. It is possible that a combination of genetic constraint, female provisioning in famine conditions (such as those experienced in the U.S. Southwest), additional cultural practices, and metabolic differences

between males and females have led to this trend. Although it is preliminary to suggest that females may be less responsive to environmental effects—any number of cultural practices could equally minimize climatic and subsistence effects—it should be noted that correlation coefficients between climatic factors and variation in female proportions and shape are also almost universally lower than those for males. Also recall, though, that there is an established sexual dimorphism in brachial index, and also that females exhibit greater amounts of directional bilateral asymmetry in upper limb lengths, both of which are related to primary growth and are less sensitive to activity and differences in mechanical loading. Together, these disparate pieces of evidence *do* suggest that there are subtle but important differences in the mechanisms of bone ontogeny between the sexes, with females less developmentally plastic than males.

The least ambiguous distinctions among the subsistence groups are, as expected, in morphologies related to activity. Marine hunter-gatherers have considerably stronger upper limbs and less upper limb bilateral asymmetry than any other subsistence group, strongly arguing for their use of upper limbs for rowing or other bimanual tasks. It is important to note that the MHG samples from the Pacific Northwest and Southeastern U.S. have the strongest upper limbs relative to lower limbs, indicating that, while other marine hunter-gatherers—especially males—were involved in upper-limb specific tasks, these populations either were less terrestrially mobile or were involved in more straining upper limb tasks. The reduction in sexual dimorphism in all femoral robusticity dimensions among MHG samples further argues for the de-emphasis on activities related to terrestrial mobility; the division of labor in marine samples remained in tasks related to the upper limb. In contrast, freshwater (inland) hunter-gatherers maintained higher sexual dimorphism in femoral anteroposterior

robusticity, which could be argued to indicate that males still engaged in different terrestrial mobility behaviors as well as tasks that involved the upper limb. However, the greatest differences in robusticity between the sexes occurred among the broad-spectrum hunter-gatherers, similar to patterns observed in the Paleolithic of Europe. From these results, it can be inferred that males on both continents were engaged in higher amounts of activity in comparison with females than any other subsistence group. This is also reflected in the significantly greater bilateral asymmetry of upper limb diaphyseal breadths, especially in the clavicle and the humerus, and their sexual dimorphism, compared to all other subsistence groups. Yet, it is important to note that BSHG males and females have the most similar strengths in the upper and lower limbs. These populations were not only more active, but they were more active in all behaviors. It is curious that sexual dimorphism tends to decrease in these dimensions among agriculturalists, but that robusticity itself is little different from horticulturalists or freshwater hunter-gatherers, against expectations. Populations involved in the focused cultivation of plants were just as active as inland hunter-gatherers, but did tend to share tasks more equally between males and females (Ruff, 1987).

As pointed out in the results, subsistence groups were not homogeneous in these morphologies. Indeed, interesting exceptions may be revealing concerning differences in exact subsistence practices within groups. For example, marine hunter-gatherers from the coast of Southern Texas were more equally balanced in the use of the upper and lower limbs than any other MHG samples, which may relate to the lack of clear evidence for extensive use of boats in these populations. Also, sexual dimorphism in average humeral diaphyseal breadth robusticity among South Texas marine hunter-gatherers (approximately 15%) was considerably lower than sexual dimorphism among broad-spectrum hunter-gatherers

(approximately 23%) in the same region, despite the evidence for mixed-sex foraging by the hunter-gatherers in this region. In fact, note that BSHG sexual dimorphism in South Texas is higher than the average for all BSHG groups (by more than 4%), while MHG sexual dimorphism is lower (by nearly 5%). Attention should therefore be focused not only on the broad patterns of variation in morphology among subsistence groups, but variation within these broadly-defined categories. It is important that, despite the coarseness of these categories, significant differences among samples could still be detected in their usage. A convincing case has been made in these analyses that these subsistence distinctions may be viably applied in further comparative research involving analysis of behavioral differences.

7.1.4: Putting the pieces together: shaping up the Americas

How, then, might the general morphological patterns of the Americas be described? Throughout the Holocene, prior to European colonization, humans in the Americas display a considerable amount of diversity in body shape, limb proportions, size, and the relative strength of the limbs. On the whole, they have remained wide-bodied relative to populations in similar environments in Europe and Africa, probably as a result of constraint on the variation of pelvic shape in relation to a number of factors, including but not limited to the mechanics of walking, the physiology related to the birth canal, and cultural buffering. Relative to the Old World, humans in the New World are as variable if not more variable in intralimb and interlimb proportions, which is related to climatic variation.

This turns to one of the initial questions set out in the Introduction: can we tell how long it was necessary for these morphological changes to occur? The fact that nasal index does not correlate with any climatic factors until approximately 2500 yBP, and intralimb indices do not correlate with climatic variables until roughly 4000 yBP, does not mean that these

varied stochastically in relation to climate until then. The lack of a correlation between climate and the variation of these proportions is likely because no arctic sample—and therefore a predominantly temperate range of climates in the available sample—predates 4000 yBP. It is not in question that these indices varied before the mid-Holocene, but there are many difficulties in making assertions about the timing of temporal change in response to climatic factors. Although climatic factors appear to be a strong influencing factor on cranial index, nasal index, intralimb index, body mass, lengths of the torso and lower limb, and, to a lesser extent, stature and body breadth, climate is not the only factor affecting variation in these. Subsistence, as has been demonstrated, has effects on stature and body mass, and may have an effect on other morphologies (though *not* relative torso height and likely not body breadth). As climate and subsistence are linked factors, attributing variation in climatic factors alone with morphological diversity is as unlikely as citing only subsistence as the influencing factor. Assuming that climate is the dominant influence on intralimb indices, for instance, regardless of mechanism, the lack of a significant correlation between these before 4000 yBP may be a result of sampling and a limited range in climatic factors. After all, no arctic samples were available prior to this date (a point I will return to shortly).

Placing these caveats aside, the data do indicate that not all morphologies covary equally with environmental factors, corroborating evidence provided in analyzing European samples (Ruff, 1994a; Holliday, 1997a). There is little question that bi-iliac breadth is less modifiable or less reactive to selection pressures relating to heat dissipation than many of the length measurements of the body, which is in keeping with the cylindrical model for surface area relative to volume. Stature has the potential to change rapidly—an observation made often in modern secular trend studies—and this is affected both by precipitation (shorter statures in

wetter environments) and by diet and nutrition. Intralimb indices may change at a slower rate than overall limb lengths. Note that, while stature, absolute torso height and lower limb length changed between hunter-gatherers and agriculturalists in the Southeastern U.S., intralimb indices generally remained the same (especially in females). This is despite the slight positive scaling in the distal elements relative to proximal elements in limbs. Trent Holliday (1997a) also noted that the rates of interlimb and intralimb proportions differ when looking at changes in these morphologies over time in Europe. Further review of exceptional patterns in regional comparisons can further refine these broad conclusions.

Most of the relationships of morphologies to environmental factors—especially climate—are strengthened by the inclusion of the arctic high latitude samples. This is because of the extreme morphologies found in populations of the arctic, especially those of the Inuit: they are universally wide-bodied (though not the widest), relatively short-limbed, and massive with relatively narrow noses and crania. I cannot emphasize enough this importance of this finding, which is one of the strongest conclusions to be drawn out of this research. It has long been acknowledged that the populations above fifty degrees latitude in the New World represent what has been regarded as the quintessential example of cold adaptations. In fact, as pointed out previously, they are the most-often cited samples from the New World used in comparative human morphological research. Clearly, though, they are the exception for morphology in the New World⁴. This, in turn, has implications for some of the models for population origins in the Americas. As established in Chapter 2, populations from the Arctic are largely descended from only two mtDNA haplotypes (A2 and D2), which is genetically restricted in comparison with the rest of North America, and certainly in contrast with South America. Given their relative genetic homogeneity and

⁴ The Inuit are not “*typical*” for the morphologies found in the Americas.

extreme morphologies, there is good evidence that the Inuit and their ancestors have been isolated from other populations from the Americas for quite some time, if not since they first arrived in the arctic. Whether they are the result of an isolated group that colonized Eastern Beringia when the remainder of humans migrating to the New World proceeded south, or a later migration from Siberia, cannot be ascertained at present. Given their unique appearance, and the evidence that archaeologically documented population expansions in the arctic all began in Eastern Beringia and then proceeded west and east, it is conceivable that the Inuit were an isolated group that arrived early in the colonization of the New World and remained in high latitudes, refining their subsistence technologies. Some did colonize northern reaches of the Pacific Northwest, as well as the Aleutian Islands, developing less extreme morphologies, but, on the whole, the appearance of the Inuit and their kin is a result of millennia of genetic and cultural isolation in the northern arctic reaches of North America. Future discoveries of older skeletons from the northern latitudes of the New World will be necessary to test this assertion.

Based on this conclusion, then, the adaptation of humans to environmental factors in the New World is best tested using the subarctic samples alone, as the inclusion of the populations from the arctic, though informative, is artificially biasing patterns. Reviewing climatic correlations with subarctic morphology within the last millennium (see Tables 6.20 and 6.21), the list of morphologies covarying with climatic factors is still extensive: cranial module, nasal index, upper body width (in males only), intralimb indices, absolute torso height, lower limb length, and body mass, with less consistent correlations with relative torso height, bi-iliac breadth (again, only in males), and stature. Yet, across all temporal periods, many of these morphologies do not significantly covary with any climatic variables in

subarctic samples as determined by examining sample means (Tables 6.15.1 and 6.15.2). It is difficult to conclude whether this discrepancy is more of an effect of statistical power (more degrees of freedom in the analyses of individuals from the last millennium) or if morphologies of recent samples are more adapted in response to climatic factors.

Importantly, in subarctic samples through all time periods, body masses in both sexes, absolute torso height and lower limb length among males, and cranial index for females (with the exclusion of high latitude samples) all continue to correlate with subsistence. The purported effects of subsistence on morphology generally persist even without the extreme morphologies of high latitude hunter-gatherers. Broader patterns of morphological variation in relation to subsistence are considered further in section 7.4.

7.2: Making sense of the muddle in the middle: movements in the Americas

As noted above, regional analyses do further refine the understanding of the relationships of morphology to climatic and subsistence factors. The arctic is one such example, though other regional analyses may elucidate morphological variation in the subarctic. Two other examples are the Great Plains and the U.S. Southwest.

Repeatedly mentioned in the Results, the samples from the Great Plains often represent an aberrant morphological pattern compared with neighboring populations and what would be anticipated based on climatic factors or subsistence alone. The Great Plains skeletons from the last millennium (especially those from the upper Missouri River Valley) exhibit relatively narrow noses, high brachial and crural indices, wide bodies, very tall statures, and high body masses. Archaeological evidence, as reviewed in Chapter 2, suggests that many of these populations were recent migrants (within 2000 years) from farther south. Based on this evidence, one would conclude that intralimb indices do not adapt to climatic factors within

relatively short periods of time (e.g., two millennia). Yet, how does this explain the narrow nasal apertures, wide body breadths and tall statures of these populations? Evidence from this dissertation's analyses suggests that the first two morphologies are commonly found in cool (and dry, in the case of nasal index) climates. The Great Plains do have rather cold winters, but the summers are warm temperate (see Tables 6.2.1-4). Contrary to the general trends for the Americas, assuming that the Caddo migration hypothesis (as supported by intralimb indices) is correct, could the populations of the Great Plains have rapidly adapted in body breadth and nasal index to this environment? Parsimoniously, this contradicts evidence for changes in body breadth in the New World as a whole, as well as that which has been documented in Europe (Holliday, 1997a,b). Instead, their morphologies are most likely retained from their ancestors to the south. In the Southeastern U.S., the Caddo-speaking samples were also the tallest, most massive, and widest-bodied of all subsistence groups (Table 6.39), though their nasal indices were high. In fact, an ANOVA comparing Great Plains samples, non-Caddo samples from the Southeastern U.S., and Caddo-speaking samples, reveals that only nasal index significantly differs ($p < 0.01$) between the Caddo-speaking samples and those of the Great Plains. Potentially, this could mean that nasal index has greater developmental plasticity than morphologies of the postcrania, or that other factors—interbreeding with populations that had occupied the high Plains previously or founder effects, for example—have influenced this morphology. On the whole, however, these results demonstrate three important conclusions: 1) there is biological evidence in body size and proportions to support the migratory hypothesis for populations in the Great Plains; 2) most morphologies of the postcrania do not significantly change (or, alternatively, were not subjected to selection pressures) within a couple of millennia, although this may be a case

in which cultural buffering limited the effects of climate; and, most importantly, 3) broad population history, as hypothesized, *can* be assessed by examining regional differences in body size, shape and proportions. It does not resolve the causes for high body masses and wide bodies among the Caddo or their kin to the northwest. However, cultural buffering or genetic constraint may be playing a significant role.

Expanding on this concept of retained morphologies by migrating populations, it might be possible to discern other movements in North America. The U.S. Southwest is one such region. Recall that intralimb indices subtly differed between groups occupying the western and eastern sides of the Continental Divide, and samples to the west of the Divide had higher crural indices, especially among males. Remember, as well, that archaeological and genetic evidence somewhat disagree over the nature of the Uto-Aztecan migration from Mexico into the U.S. Southwest with the introduction of maize. Although not all of the groups to the west of the Continental Divide in this sample were associated with the Hohokam, this is the geographic area in which biological evidence (Turner's dental evidence and Malhi et al.'s Y-chromosome data) argues Uto-Aztecan speaking populations from Mexico entered via migration and colonization, or was adopted via significant gene flow from the south. In point of fact, Malhi et al. (2003) argued for Y-chromosome contributions to all populations to the west of the Divide (including the Yuma). It is unlikely a coincidence that the higher intralimb indices are also found among samples from this same region. Climatic variables do not differ east and west of the Continental Divide, as indicated in the Results (see Figure 6.4), especially temperature, which has been shown to significantly correlate with intralimb indices. One might then conclude that the populations to the west of the Divide either developed higher crural indices as a result of a founder effect, or, more likely, have them as a

result of different gene flow related to the migration of peoples from further south, where temperatures are higher and intralimb indices were likely as well. In addition, some gene flow from the Athapascans *east* of the Divide may have had an effect on body proportions as well in that geographic area. Their genetic contribution (e.g., contributing lower intralimb indices) could have significantly affected any gene flow crossing the continental divide, just as the Uto-Aztecan genetic contribution might have affected gene flow in the opposite direction. Interestingly, this would argue for an influential genetic component in the determination of limb proportions, or at least a restriction on the amount of plasticity in the responsiveness of the limb proportions to temperature. Such conclusions, while mere conjecture at this point, merit further investigation.

Overall, then, there is little evidence for rapid change in most of the morphologies determined to covary with climate (as argued by Trinkaus, 1981). These two examples from the Great Plains and U.S. Southwest also demonstrate that population movements in the Americas (as argued by Jantz, 2006) may be outpacing the rapidity by which morphologies adapt to environmental effects, and so are muting (or confounding) the covariation of some morphologies with climate. Cultural practices play an additional role, and so confound the time necessary for climatic selection pressures to affect morphology, which is in turn a function of the duration of occupation by a population in a climate. While cultural buffering is a factor that cannot be taken into direct consideration, it very likely has had an effect on morphological variation. As I noted above, though, heat stress cannot be substantially reduced by cultural buffering in archaeological populations. Similarly, the effects of extreme cold will still have a selective effect even with the use of clothing, fire, and shelter; without a doubt, humans could not have survived in the arctic without these technologies. Indeed,

although cultural buffering may impact the influence of climate on morphological variation, its role is variable. Thus, the effects of migration remain a significant factor in assessing the effects of climate on morphology.

Combining these various, interactive factors influencing morphological variation—climate, subsistence, migration and population history—what might be concluded about the variation noted on the earliest skeletons from the Americas and their implications for the populating of the Americas? It has already been argued that these skeletons may indicate “cold filtering,” though by 9000 yBP other morphologies had started to vary among these individuals—namely, stature, intralimb indices, and body mass—undoubtedly in response to different subsistence modes, climates, and genetic differentiation. Although this morphological variation does not demonstrate the extreme morphologies later found in either the arctic or in the tropics, it does match the range found in temperate samples. Given that at least five or six millennia had already elapsed since the first migrants began to colonize the Americas, this is not surprising. Over such a wide geographic range, it would be incredible to assume that these skeletons came from morphologically homogeneous populations. Yet, a comparison of Wizard’s Beach and Spirit Cave, both dating from approximately identical times and geographically very close, shows that this variation was not a result of geographic distance alone. Even though this is an isolated example, their contrasting morphologies—Spirit Cave’s lower body mass, interlimb index, and crural index compared with Wizard’s Beach—and their reported differences in cranial morphology (Jantz and Owsley, 2001), argue for genetic isolation between the populations to which these individuals belonged. Although the os coxae of Wizard’s Beach were not preserved, it would likely be a well-informed assumption that his body was broad, like Kennewick and Spirit Cave (especially

given his high body mass). Both Spirit Cave and Wizard's Beach retained this "cold-filtered" morphology, though climate and population history had already started to produce different body proportions between their populations. One might even conclude that one or both of these populations was a recent migrant to the region, though this cannot be tested and is based on tenuous evidence. The differences in their morphologies despite geographic and temporal proximity, however, combined with the evidence reviewed above, does lend some support to this idea.

Regardless, one may conclude with more certainty that, by the early Holocene, most humans in the New World already demonstrated signs of tribalization, a model that has been gaining support from all fields of study in the population history of the New World. Given that the initial migrants were moving into an ever-changing, mosaic environment, the need for rapid technological adaptation to variable climatic and ecological conditions may have encouraged the rapid separation of groups, coupled with wide-ranging foraging practices. Whether this tribalization occurred rapidly as humans moved into the Americas 15,000 years ago, or gradually, cannot be assessed with the available data.

7.3: Thinking globally: broader implications

The morphology of the earliest Holocene skeletons may be further applied to addressing models of origins for humans in the Americas. Given the wide bi-iliac breadths and high body masses among the early Holocene male skeletons, what might be said of their ancestors and the geographic origins of those individuals? As explained in Chapter 2, the Asian origin for New World populations is largely unquestioned, but there is much contention about from where in Asia this population (or populations) came. For example, recall that Neves (e.g., Neves et al., 2007) has repeatedly argued for a Southeastern Asian affinity in cranial

dimensions for South American early Holocene specimens, which has been echoed by the research of Jantz and Owsley (2001). Geneticists, however, have pointed to a southern Siberian origin for the mtDNA haplogroups found in modern populations. The specific solution to this question cannot be addressed directly here, but some inductive reasoning points to more parsimonious solutions.

Laura Shackelford (2007) examined available specimens from the East Asian Late Upper Paleolithic (LUP, approximately 20,000 yBP to the beginning of the Holocene). She reported a mean body mass of 52.9 kg ($n = 10$, using the STBIB body mass estimation formula) and a mean bi-iliac breadth of 251.1 mm ($n = 7$) for these LUP Asian samples, which are lower than those I report among the early Holocene North American skeletons (see Table 6.48). The statistics in Shackelford's paper were calculated for combined sexes, however. In her dissertation, Shackelford (2005) presented the body mass and bi-iliac breadth, if available, for all of her LUP specimens. Among those from Southeastern Asia, only three male specimens are available. These three males generally have smaller femoral head-derived body masses (39.6 kg and 66.3 kg from the LUP of Laos, and 58.6 kg from the LUP of southern Japan) than the North American early Holocene males, and only one of the Asian LUP specimens (Tam Hang 20538, from Laos) preserves a bi-iliac breadth (258 mm). Although this is a small sample, it may be generalized that at least two populations living in Southeastern Asia were narrower (by more than 2 cm) and less massive than populations living in North America 9000 to 7000 years later.

Based on these limited data, it is unlikely that the early Holocene individuals from North America were descended from populations from Southeastern Asia. Were there a direct ancestor-descendant relationship between these populations, it would imply that the

narrower-bodied (BIB less than 26 cm) Southeast Asian populations experienced body breadth increases relatively rapidly (i.e., within 5000 years), assuming that the 18,000 year-old skeletons from Okinawa (Minatogawa site) represent the first appearance of narrow-bodied humans north of the Tropic of Cancer in East Asia. As discussed by Ruff (1994a) and buttressed by this dissertation, adaptation in pelvic breadth is among the least rapid of the morphologies that appear to respond to climate or subsistence. Thus, the pelvic breadths of the earliest Holocene skeletons from the Americas—representing populations that had almost certainly existed for some millennia in the New World—agree with the genetic evidence that points to a central Siberian origin for the humans that colonized the Western Hemisphere. Given that the male skeletons measured by Jay Stock from Lake Baikal had pelvic breadths and body masses similar to those reported for one of the males from Laos (Tam Hang 20538)—despite 10,000 years and thousands of kilometers separating these populations—it is possible that the ancestors for Kennewick, Spirit Cave, Wizard’s Beach and Horn Shelter came from farther into northwestern Siberia. (Of course, the samples observed by Stock could have represented recent migrants to Siberia themselves.) Considering the foregoing, there is little current postcranial morphological support for the rapid coastal migration of Late Pleistocene populations from southern Asia (the “Sundaland”), through Beringia, and into the Americas.

How, then, can the craniometric affinities with Paleolithic Southeastern Asians among the early Holocene New World skeletons be reconciled with this perspective? As clearly indicated by the few cranial variables considered in this study, there is a great amount of independence of cranial and postcranial shape. Potential selection pressures associated with climate and subsistence affecting the postcrania do not equally affect crania in the same

populations. It is possible, then, that a common population was ancestral to both those found in the Paleolithic of Southeastern Asia and the early Holocene populations from the Americas. Postcranial adaptations would have occurred in the more northern representatives of this population, who subsequently entered the New World (possibly in multiple waves), while some cranial features remained unchanged. This assumes that the cranial shape affinities are a result of shared population histories and not common responses to environmental selection pressures.

Although it cannot be ascertained directly, assuming that these early Holocene populations from North and South America were similar to broad-spectrum hunter-gatherers from more recent temporal periods, these early groups would have been more sexually dimorphic in body size than most other groups that would later be found in the Americas. It is interesting, however, that the village horticulturalist/hunters were as dimorphic as the BSHG groups in this respect, though the BSHG groups were much more dimorphic in robusticity and in asymmetry of the upper limbs. This, in turn, suggests that the division of labor between the sexes in the earliest foragers and hunters was greater than activity differences in later populations, but that it was maintained in some regions, namely, the Great Basin and Southern (inland) Texas.

7.4: Where do we go from here? Future directions and considerations

The results presented in this dissertation, while extensive and informative, do not exhaust the possible analyses that may be conducted. For the sake of brevity⁵, a number of additional analyses that were conducted have not been reported or have been relegated to appendices. Also, as stated at the beginning of this chapter, this Discussion has ignored a

⁵ Brevity?! Surely I jest.

number of interesting (though somewhat tangential) results reported in the previous chapters. With the available data in the POD, a large number of additional analyses not conducted are also possible, such as more detailed analyses on morphological integration, the effect of terrain differences or altitude on the skeleton, or the influence of environmental effects on dimensions or morphologies not tested (such as articular dimensions). Indeed, these are interesting additional avenues of research that are beyond the scope of this current research, but should be investigated.

Even with data from 2749 skeletons, there is call for more skeletal data from additional skeletons. This study has given little notice to variation in Mesoamerica and South America, as well as the Eastern Arctic, the Great Lakes, and the St. Lawrence River Valley (including Newfoundland). Archaeologists and morphologists have argued that South America is likely more culturally and phenotypically variable than North America (Dillehay, 2000; Neves et al., 2007). Also, by including Latin American pre-contact skeletons, additional questions can be tested: What are the effects of state society on the patterns of morphological variation? The development of a highly socially stratified society has been implicated to differentially affect the morphologies of the skeleton (stature and robusticity, for example); could it also have influenced body proportions? Can the forced movement of people—such as that practiced by the Inca—be detected in proportions and shape differences? How do various tropical environments affect the skeleton in the Americas, and are these changes similar to the patterns observed in Africa and Asia? Stinson (1990) documented a number of patterns in South America that, unfortunately, cannot be examined further with the available data in this dissertation.

With the addition of more archaeological samples, the inclusion of more early Holocene skeletons would be equally beneficial. As noted in Chapter 2, there are a number of skeletons available that I did not have the opportunity to observe directly⁶—Wizard’s Beach, Gordon Creek, La Brea and all of the skeletons from Brazil are obvious examples—though they are crucial in more fully developing an idea of the total morphological variation present in the earliest known skeletons from the Americas. Moreover, while female early Holocene skeletons were observed, none could be used in this analysis, though it is established that female morphology significantly differs from male morphology in relation to environmental factors. Adding measurements from skeletons like “Luzia” and São Raimundo, then, would be quite useful.

Along with more data from skeletons from unexamined regions, data from additional measurements would also be beneficial. External diaphyseal breadths do reveal a great amount of information about activity, as demonstrated above, but the use of limbs can be better modeled using cross-sectional data (O’Neill and Ruff, 2004). In addition, the inclusion of cross-sectional data would allow for the examination of differences in cortical bone structure among subsistence groups to better understand the effects of diet and activity on bone properties. Thus, including bone CT data would be a useful addition to these data.

One of the greatest restrictions in the cranial data collected is that the measurements provide only coarse representations of shape. For example, upper face height is affected by frontal supraorbital bossing and prognatism, so the lack of a clear relationship between facial index and climate or subsistence may be due to a lack of representation of these three-dimensional relationships. More cranial data reflecting the three-dimensional structure of the

⁶ I should note, though, that it has been a rare opportunity for me to have observed the many skeletons as I did for data collection.

face and neurocrania, then, would also be useful in determining the relationship of cranial shape to climate and subsistence, as already demonstrated by many other authors (e.g., Havarti and Weaver, 2006, and papers cited therein).

Finally, the collection of data from juveniles⁷ is likely the most important potential addition to the POD. As noted in Chapter 3, the adult morphology tested in this dissertation results from the combined effects of genetics and environment through ontogeny. Yet, there are few studies that have explicitly examined variation in juvenile proportional and shape variation in relation to environmental factors (Ruff and Walker, 1993), especially in the Americas. With new methods to estimate body mass from juvenile skeletal remains (Ruff, 2007), there is added incentive for collecting data from subadult archaeological remains. Only by examining variation among juveniles in relation to environmental factors—especially climate—will the question of the relative contribution of genetic and climatic effects on the skeleton be more fully addressed.

7.5: Conclusions: human skeletal variation in the New World during the Holocene

Placing these future considerations aside, the results of this study have shed light on a number of topics concerning human morphological variation in the Americas before extensive European colonization. It is the first study, to date, to examine morphological variation systematically through time and across geography throughout the Holocene of North America and, to a lesser extent, the Americas as a whole. From its analyses and discussion, there are a number of conclusions that should be emphasized:

⁷ Note that there is the conundrum that juveniles represent members of a population that, for a variety of reasons, did not survive to adulthood, and therefore may have been adaptively unfit.

- The New World has never been morphologically homogeneous. The earliest skeletons from the Holocene exhibit a range of morphologies that are found among more recent samples across temperate climates. However, more recent populations show greater ranges of variation in all morphologies.
- Many of the morphologies that differ across the Americas have ranges of variation that are similar to those found in Europe and Africa. Body mass, body breadth, and stature do not reach the smallest extremes found in some tropical Old World populations among New World populations. However, Europeans do not have pelvic breadths or body masses as high as those found in some North American samples.
- There is strong evidence that populations of the North American arctic represent a group isolated from the remainder of the Americas, whose morphology developed after many millennia spent living in cold polar zones. As such, in the use of high arctic samples from the Americas in assessing variation in the New World, or in comparisons with any populations, this effect of population history and adaptation should be taken into account.
- Populations in the New World do exhibit morphological covariation with climatic factors. Although a direct, causal relationship between climate and morphological variation cannot be proven, it is likely that this covariation relates to morphological adaptation for heat dissipation or retention. Intralimb indices, torso length, lower limb length, nasal index, and body mass (as well as cranial module) all relate to climatic variables, with most relating to both the mean annual temperature and either mean winter or summer temperature extremes. Note that precipitation, as a proxy for environmental moisture, has an inconsistent relationship, but that, in general, higher

- intralimb indices coincide with drier climates, while shorter statures and relatively wider nasal apertures are found among peoples from wetter climates.
- Body breadth also exhibits a relationship with climate; populations in overall warmer environments tend to have narrower bi-iliac breadths. However, all humans in the New World tend to have wider pelves than are observed in the Old World, especially sub-Saharan Africa. This is likely a result of multiple factors, including possible “cold-filtering” of original founding populations, constraint on variation in pelvic morphology due to obstetric and mechanical limitations, as well as some cultural buffering.
 - Subsistence practices affect stature, though not as anticipated. Agriculturalists and horticulturalists are often as tall as, if not taller than preceding hunter-gatherer samples from the same regions. In addition, there is no systematic effect of subsistence on body mass or any other morphologies (e.g., cranial index, absolute torso height, lower limb length). As climate and subsistence are highly linked, however, disentangling the effects of one environmental factor from the other is difficult and likely not useful. Morphological variation, especially in stature, is a combination of both of these environmental factors’ interactions with genetic potentials.
 - That there are genetic and population history effects that also influence morphology cannot be ignored. For example, as previously demonstrated using data from the Boas Columbian Exposition data (Jantz, 2006), this study has shown that populations on the eastern side of North America tend to be considerably taller than populations living in the Great Basin, Pacific Northwest, California, or the U.S. Southwest. This

pattern does not correspond with climatic or subsistence factors, and so is most likely related to the effects of population history.

- Marine hunter-gatherers demonstrate sexual divisions of labor in which males were engaged in more bimanual tasks—most likely rowing. However, the greatest difference between males and females in limb robusticity is found among the samples practicing broad-spectrum hunting and gathering, while more equality in activity is found among incipient horticulturalists and agriculturalists.
- Most of the proportions and dimensions examined do not change rapidly (i.e., within a couple of millennia) through time. This is borne out by examples of recent migrations of populations in North America from one region to another. Nasal index may exhibit some potential for rapid changes in shape. Also, brachial index may be more developmentally plastic or genetically variable than crural index, though these proportions show signs of integration with each other.
- Body proportions may be used as an indicator of recent population history, especially in locations wherein a recent migration is suspected. Two examples shown in this dissertation are the recent migrations of Caddo-speaking populations into the Great Plains, as well as population differences along the Continental Divide.
- Through time, patterns of morphological change in the New World parallel those observed in the Old World during the late Pleistocene and Holocene: bilateral directional asymmetry and absolute asymmetry in upper limb diaphyseal breadth decreases, overall skeletal robusticity tends to decrease in the upper limb or lower limb, overall body mass decreases, and sexual dimorphism reduces in all of these and other morphologies.

In conclusion, this study has shown that much can be gleaned from relating morphologies reconstructed from the skeleton directly to modeled paleoclimatic data and broad subsistence categories. There is, therefore, much potential for applying this methodology in other regions of the globe, especially in determining the relative effects of environment on and rates of change in human morphological diversity. In this application, biological anthropologists may obtain a more holistic account of the morphological variation observed among humans, both in the Old and New World.

**HUMAN SKELETAL VARIATION IN THE NEW WORLD DURING
THE HOLOCENE: EFFECTS OF CLIMATE AND SUBSISTENCE
ACROSS GEOGRAPHY AND TIME – PART II**

by

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"I HAVE SOME FEW REFERENCES TO MAKE."

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A guide to the abbreviations and acronyms employed in the text:

General terms:

AST	Alaskan Small Tool tradition
COD	Comparative Osteological Data Set (see Chapter 4, section 4.1)
EOD	Extended Osteological Data Set (see Chapter 4, section 4.1)
LGM	Last Glacial Maximum
MNI	Minimum number of individuals
mtDNA	mitochondrial DNA
POD	Principal Osteological Data Set (see Chapter 4, section 4.1)
yBP	years before the present (using 1950 as the date for the “present”)

Anatomical orientation terms:

AP	Anteroposterior
ML	Mediolateral
SI	Superoinferior

Osteometric measurements (see Appendix II):

ACH	Maximum acetabular height
BBH	Basion-bregma height (neurocrania height)
BIB	Bi-iliac breadth
CAPD	Clavicular 50% diaphyseal anteroposterior diameter
CML	Clavicular maximum length
CSID	Clavicular 50% diaphyseal superoinferior diameter
EUB	Euryon-euryon breadth (calvaria breadth)
FAB	Femoral distal articular (bicondylar) mediolateral breadth
FAPD	Femoral 50% diaphyseal anteroposterior diameter
FBL	Femoral bicondylar (physiological) length
FEB	Femoral epicondylar breadth
FHD	Femoral head anteroposterior diameter
FIML	Fibular maximum length

FML	Femoral maximum length
FMLD	Femoral 50% diaphyseal mediolateral diameter
GOL	Glabella-opisthocranium length (calvaria length)
HAB	Humeral capitulum-trochlea mediolateral breadth
HAPD	Humeral 50% diaphyseal anteroposterior diameter
HEB	Maximum humeral epicondylar mediolateral breadth
HHD	Superoinferior diameter of the humeral head
HML	Maximum humeral length
HMLD	Humeral 50% diaphyseal mediolateral diameter
IBL	Maximum iliac blade length
JNB	Intraclavicular facet breadth
MAC#	Anterior midline superoinferior height of cervical vertebrae
MAL#	Anterior midline superoinferior height of lumbar vertebrae
MAT#	Anterior midline superoinferior height of thoracic vertebrae
NAB	Alare-alar breadth (nasal aperture breadth)
NAH	Rhinion-nasospinale height (nasal aperture height)
RAB	Distal radial articular surface mediolateral breadth
RAPD	Radial 50% diaphyseal anteroposterior diameter
RAPH	Radial head anteroposterior diameter
RML	Maximum radial length
RMLD	Radial 50% diaphyseal mediolateral diameter
RMLH	Radial head mediolateral diameter
SML	Maximum sagittal superoinferior height of the sacrum
TAPD	Tibial 50% diaphyseal anteroposterior diameter
TCH	Talus-calcaneus height
TDA	Average tibial distal articular breadth
TDAP	Tibial distal articular surface midpoint anteroposterior breadth
TDAX	Tibial distal articular surface maximum anteroposterior breadth
TDML	Tibial distal articular surface mediolateral breadth
TFL	Tibial “Fully technique” length
TML	Tibial maximum length

TMLD	Tibial 50% diaphyseal mediolateral diameter
TPAB	Tibial proximal articular mediolateral breadth
TPB	Tibial plateau mediolateral (bicondylar) breadth
TTB	Talar trochlea anteroposterior midpoint breadth
UAPD	Ulnar 50% diaphyseal anteroposterior diameter
UFH	Prosthion-glabella length (upper face height)
UML	Ulnar maximum length
UMLD	Ulnar 50% diaphyseal mediolateral diameter
XC#	Maximum superoinferior height of cervical vertebrae
XL#	Maximum superoinferior height of lumbar vertebrae
XS1	Maximum superoinferior height of S1 vertebra
XT#	Maximum superoinferior height of thoracic vertebrae
ZYB	Zygion-zygion breadth (upper face breadth)

Derived morphologies:

%AA	Percent absolute bilateral asymmetry
%DA	Percent directional bilateral asymmetry
ATH	Absolute torso height
BI	Brachial index
BM	Body mass (generally referring to FH BME)
CAD	Clavicular average 50% diaphyseal diameter
CI	Crural index
CRI	Cranial index
CRM	Cranial module
FAD	Femoral average 50% diaphyseal diameter
FH BME	Femoral head (“mechanical”) derived body mass estimation
FI	Facial index
HAD	Humeral average 50% diaphyseal diameter
ILI	Interlimb index
LLL	Lower limb length
NI	Nasal index

RAD	Radial average 50% diaphyseal diameter
RTH	Relative torso height
ST	Stature (Fully technique)
STBIB BME	Stature-bi-iliac breadth (“morphometric”) derived body mass estimation
TAD	Tibial average 50% diaphyseal diameter
TH	Thoracic height (the sum of XT1 to XL5)
UAD	Ulnar average 50% diaphyseal diameter
ULL	Upper limb length
ULTH	Relative upper limb length/torso height
UTB	Upper torso breadth

Climatic and geographic categories:

LAT	Latitude
LONG	Scaled longitude
MAT	Mean annual temperature
MNT	Coolest month mean low temperature
MTP	Mean total annual precipitation
MXT	Warmest month mean high temperature

Subsistence categories:

AGR	Agriculturalist
BSHG	Broad-spectrum hunter-gatherer
FHG	Freshwater hunter-gatherer
IH	Incipient horticulturalist
MHG	Marine hunter-gatherer
VHH	Village horticulturalist/hunter

Statistical terms:

%SEE	Percent standard error of the estimate
ANOVA	Analysis of variance
CI	Confidence interval (generally referring to the 95% CI)

COV	Coefficient of variation
DFA	Discriminant function analysis
MANOVA	Multivariate analysis of variance
OLS	Ordinary least squares (Type I) regression
RMA	Reduced major axis (Type II) regression
SEE	Standard error of the estimate
SS	Sums of squares
V/CV	Variance-covariance matrix

Appendix I. Sample information for data collected by BMA (Principal Osteological Dataset)

Notes: ¹ The archaeological site designation used here is not available for sites that were not professionally excavated, for skeletons that were donated to collections, and for some sites excavated by professionals but not given a site number. Most sites exhumed in the United States have been given Smithsonian trinomials (state number-county abbreviation-site number), but some states have not incorporated this system. Canadian sites are generally designated using the Borden System.

² Subsistence categories are explained in the Methods section (after Wescott, 2001) and in Table 4.9: **BSHG**, broad-spectrum hunter-gatherer; **FHG**, freshwater hunter-gatherer; **MHG**, marine hunter-gatherer; **IH**, incipient horticultural; **VHH**, village horticulturalists/hunters; **AGR**, agricultural.

³ Individuals of uncertain sex (i.e., probable males and females) are listed as the third number (“?”) here, and are included in analyses as described in the methods.

⁴ This category provides a brief summary of the general preservation of the skeletons available from this site at the time of observation and measurement. The categories used are:

E/C , excellent/complete:	On average, more than 90% of all measurements could be taken on skeletons from the sample
VG/NC , very good/nearly complete:	On average, more than 75% of all measurements could be taken on skeletons from the sample
G/I , good/incomplete	On average, more than 50% of all measurements could be taken on skeletons from the sample
P/F , poor/fragmentary	On average, more than 25% of all measurements could be taken on skeletons from the sample
VP , very poor	On average, less than 25% of all measurements could be taken on skeletons from the sample

ALASKA

1) Site number¹: None assigned

Site name: Aleutian Islands (Hrdlička's "Pre-Aleut")

Location(s): Central Aleutian Islands (the Fox Islands): most skeletons from a mound near to the village of Nikolski on Umnak Island (52.94, -168.86), though a couple are from Ship Rock Island (53.37, -167.84)

Time period(s): ca. 4000 to 1000 yBP (relative dating)

Region: Western Arctic

Cultural affiliation: Not known

Subsistence²: MHG

Number of individuals observed (♂/♀/?)³: 12/16/0

Condition of remains at time of measurement⁴: VG/NC

Institution holding remains: National Museum of Natural History (Smithsonian), Washington, DC

Excavator (or donor) and date of excavation: Ales Hrdlička (1930s)

Description of site: The skeletons from Umnak were located in a mound constructed near the southwestern coast of the island (the Chaluka Midden), adjacent to the aboriginal village of Nikolski. Those few skeletons from Ship Rock Island, off the northwestern coast of Umnak Island, were found in burial caves.

References: Hrdlička, 1945; Laughlin, 1956; Frolich et al., 2002; Coltrain et al., 2006

2) Site number¹: None assigned

Site name: Aleutian Islands (Hrdlička's "Neo-Aleut")

Location(s): Throughout the Aleutian Island chain, including the Near Islands (Agattu Island, 52.43, 173.58), Rat Islands (Amchitka Island, 51.50, 179.05), Adreanof Islands (Adak Island, 53.13, -168.69; Kanaga Island, 51.92, -177.17; Atka Island, 52.38, -174.15), Islands of the Four Mountains (Kagamil, 52.97, -169.71), and Fox Islands (Umnak Island, 52.94, -168.86; Ship Rock Island, 53.37, -167.84; Unalaska Island, 51.87, -176.60; Amoknak Island, 53.90, -166.54). The majority of skeletons were uncovered at Kagamil Island.

Time period(s): 1000 to 400 yBP (relative dating)

Region: Western Arctic

Cultural affiliation: Aleut (Unangan)

Subsistence²: MHG

Number of individuals observed (♂/♀/?)³: 37/18/0

Condition of remains at time of measurement⁴: VG/NC

Institution holding remains: National Museum of Natural History (Smithsonian), Washington, DC

Excavator (or donor) and date of excavation: Ales Hrdlička (1930s)

Description of site: The majority of the skeletons were excavated from the "warm caves" of Kagamil Island and from Ship Rock Island, and had been purposefully mummified. Small numbers of skeletons were recovered by Hrdlička from individual interments on the other islands. As there was a continuous cultural exchange and travel among the Aleutian Islands, this sample is treated as representative of a single genetic population.

References: Hrdlička, 1945; Laughlin, 1956; Hunt, 2002; Frolich et al., 2002; Coltrain et al., 2006

3) Site number¹: None assigned

Site name: Ikogmiut

Location(s): Multiple locations in southwestern Alaska along the Yukon River (Anvik, 62.66, -160.21; Bonasila, 62.32, -160.50; Holy Cross, 62.18, -158.77; Ingrehak, 61.57, -159.78; New Hamilton, 62.9, -163.89; Paimute, 61.57, -159.78; Pilot Station, 61.94, -162.88; Shageluk, 62.68, -159.56)

Time period(s): ca. 1000 yBP to 100 yBP

Region: Western Arctic

Cultural affiliation: Yup'ik (Inuit and/or Athabascan)

Subsistence²: FHG

Number of individuals observed (♂/♀/?)³: 30/30/1

Condition of remains at time of measurement⁴: VG/NC

Institution holding remains: National Museum of Natural History (Smithsonian), Washington, DC

Excavator (or donor) and date of excavation: Ales Hrdlička, 1926-1929

Description of site: Many sites were described by Hrdlička as individual or small grouped inhumations, buried in the remains of habitations or near to archaeological or ethnographic villages. The majority of skeletons were obtained from the Holy Cross and Pilot Station areas.

References: Hrdlička, 1930; de Laguna, 1936; Hrdlička, 1943

4) Site number¹: None assigned

Site name: Kuskowagamiut

Location(s): Multiple locations in southwestern Alaska along the Kuskokwim River (Apogak, 61.58, -159.52; Bethel, 60.79, -161.76; Kuskogamute, 60.86; -157.83; Napaimute, 61.55; 158.68; Bogus Creek, 61.19; -160.79)

Time period(s): ca. 1000 yBP to 100 yBP

Region: Western Arctic

Cultural affiliation: Yup'ik (Inuit and/or Athabascan)

Subsistence²: FHG

Number of individuals observed (♂/♀/?)³: 14/14/0

Condition of remains at time of measurement⁴: VG/NC

Institution holding remains: National Museum of Natural History (Smithsonian), Washington, DC

Excavator (or donor) and date of excavation: Ales Hrdlička, 1926-1929

Description of site: Many sites were described by Hrdlička as individual or small grouped inhumations, buried in the remains of habitations or near to archaeological or ethnographic villages. The majority of skeletons were obtained from the Bethel and Napaimute areas.

References: Hrdlička, 1930; de Laguna, 1936; Hrdlička, 1943

5) Site number¹: None assigned

Site name: Point Barrow

Location(s): Northernmost point of mainland Alaska, near Kugusgaruk (71.39, -156.48)

Time period(s): ca. 1000 yBP

Region: Western Arctic

Cultural affiliation: Birnirk culture

Subsistence²: MHG

Number of individuals observed (♂/♀/?)³: 20/9/0

Condition of remains at time of measurement⁴: G/I

Institution holding remains: National Museum of Natural History (Smithsonian), Washington, DC

Excavator (or donor) and date of excavation: William B. van Valin (1917-1919)

James A. Ford (1931-1932)

(Point Barrow, continued)

Description of site: Burials were placed into three mounds, two located in a gully and one on a sandy spit. A couple dozen funerary objects indicated that these skeletons were most likely associated with the Birnirk culture.

References: NMNH Repatriation Office Report (Ousley, 2004); Stanford, pers. comm. 2006

6) Site number¹: None assigned

Site name: Point Hope – Birnirk

Location(s): Northwestern Alaska, on the Point Hope peninsula (68.34, -166.80)

Time period(s): 1500 to 1000 yBP

Region: Western Arctic

Cultural affiliation: Inuit (Birnirk culture)

Subsistence²: MHG

Number of individuals observed (♂/♀/?)³: 1/0/0

Condition of remains at time of measurement⁴: G/I

Institution holding remains: American Museum of Natural History, New York, NY

Excavator (or donor) and date of excavation: Helge Larsen, Froeligh Rainey (1939-1941)

Description of site: This site was located on the edge of the Point Hope peninsula, along a sand bar west of the Marryat Inlet. One of three graves recovered north of the Tigara village site, this burial had been placed into a log coffin in a shallow grave.

References: Larsen and Rainey, 1948

7) Site number¹: None assigned

Site name: Point Hope – Ipiutak

Location(s): Northwestern Alaska, on the Point Hope peninsula (68.34, -166.80)

Time period(s): 2100 to 1500 yBP

Region: Western Arctic

Cultural affiliation: Inuit (Norton culture, terminal stage)

Subsistence: MHG

Number of individuals observed (♂/♀/?)³: 18/16/0

Condition of remains at time of measurement⁴: VG/NC

Institution holding remains: American Museum of Natural History, New York, NY

Excavator (or donor) and date of excavation: Helge Larsen, Froeligh Rainey (1939-1941)

Description of site: This site was located on the western edge of the Point Hope peninsula, along the western side of the Marryat Inlet. Five rows of houses were located alongside the Arctic Ocean and next to a salt water lake. The cemetery extended for 5 miles inland along the Marryat Inlet; graves were in two clusters and along the shore of the inlet.

References: Larsen and Rainey, 1948

8) Site number¹: None assigned

Site name: Point Hope – Norton

Location(s): Northwestern Alaska, on the Point Hope peninsula (68.34, -166.80)

Time period(s): 3000 to 2000 yBP

Region: Western Arctic

Cultural affiliation: Inuit (Norton culture)

Subsistence²: MHG

Number of individuals observed (♂/♀/?)³: 1/1/0

Condition of remains at time of measurement⁴: G/I

Institution holding remains: American Museum of Natural History, New York, NY

(Point Hope – Norton, continued)

Excavator (or donor) and date of excavation: Helge Larsen, Froeligh Rainey (1939-1941)

Description of site: Located on the western edge of the Point Hope peninsula, along the southern side of the Marryat Inlet. These graves were intermixed with slightly later Ipiutak graves.

References: Larsen and Rainey, 1948

9) Site number¹: None assigned

Site name: Point Hope – Tigara

Location(s): Northwestern Alaska, on the Point Hope peninsula (68.34, -166.80)

Time period(s): 800 to 300 yBP

Region: Western Arctic

Cultural affiliation: Inuit (Tigara culture?)

Subsistence²: MHG

Number of individuals observed (♂/♀/?)³: 21/22/1

Condition of remains at time of measurement⁴: E/C

Institution holding remains: American Museum of Natural History, New York, NY

Excavator (or donor) and date of excavation: Helge Larsen, Froeligh Rainey (1939-1941)

Description of site: Located on the point of the western edge of the Point Hope peninsula, along the Arctic Ocean, this was the site of the archaeological “Old Tigara” village. Graves were placed in aligned clusters to the north and east of this site. All Tigara burials were to the west of the Ipiutak burials, and were placed in shallow graves that had been somewhat disturbed by the modern Tigara, digging for artifacts to sell or trade.

References: Larsen and Rainey, 1948

ARIZONA

10) Site number¹: None assigned

Site name: Canyon del Muerto

Location(s): Northeastern Arizona, in the Canyon de Chelly region (36.18, -109.43)

Time period(s): 900 to 600 yBP (?)

Region: U.S. Southwest

Cultural affiliation: Ancient Pueblo (“Anasazi”)

Subsistence²: AGR

Number of individuals observed (♂/♀/?)³: 18/11/1

Condition of remains at time of measurement⁴: G/I

Institution holding remains: American Museum of Natural History, New York, NY

Excavator (or donor) and date of excavation: Earl H. Morris (1920s)

Description of site: These skeletons were found in caves and under rock ledges in the Canyon del Muerto. They have been attributed to the Ancient Pueblo culture (“Anasazi”), though there may be a mixture of late Basketmaker III skeletons in the sample used. Little specific site information has been published on this sample, and artifact associations are not known.

References: Kidder, 1925; Giles and Bleibtreu, 1961

11) Site number¹: NS605

Site name: Carter Ranch (Joint Site)

Location(s): East-central Arizona, east of the city of Snowflake (34.55, -109.94)

Time period(s): 950 to 600 yBP

Region: U.S. Southwest

Cultural affiliation: Mogollon (Pueblo)

(Carter Ranch, continued)

Subsistence²: AGR

Number of individuals observed (♂/♀/?)³: 9/7/0

Condition of remains at time of measurement⁴: VG/NC

Institution holding remains: Field Museum of Natural History, Chicago, IL

Excavator (or donor) and date of excavation: John Hanson, Michael Schiffer (1970-1971)

Description of site: A pueblo consisting of a single block of 33 rooms, this site was constructed near to a separate, incomplete structure that may have been a kiva or similar ceremonial structure.

References: Schiffer, 1976; Danforth et al., 1994; internal report, Field Museum of Natural History

12) Site number¹: AZ P:14:1

Site name: Grasshopper

Location(s): East-central Arizona, Salt River drainage (34.083, -110.66)

Time period(s): 675 to 550 yBP

Region: U.S. Southwest

Cultural affiliation: Mogollon (Pueblo)

Subsistence²: AGR

Number of individuals observed (♂/♀/?)³: 27/21/0

Condition of remains at time of measurement⁴: E/C

Institution holding remains: Arizona State Museum, University of Arizona, Tucson, AZ

Excavator (or donor) and date of excavation: Walter Hough (1919-1920)

Raymond H. Thompson (1963-1993)

Description of site: A structure of multiple room blocks and plazas, including three main room blocks and multiple habitation units. This was likely an aggregation pueblo. Burials were made in the floors of room blocks, the plazas, and outside the central portion of the pueblo.

References: Berry, 1983, 1985; Ezzo, 1993; Riggs, 2001; Whittlesey and Reid, 2001

13) Site number¹: AZ V:4:1

Site name: Kinishba (Ma'ip'ovi)

Location(s): East-central Arizona, near Whiteriver, Apache Reservation (33.83, -109.97)

Time period(s): 700 to 550 yBP

Region: U.S. Southwest

Cultural affiliation: Mogollon (Pueblo) (influences by Little Colorado and Gila?)

Subsistence²: AGR

Number of individuals observed (♂/♀/?)³: 13/11/1

Condition of remains at time of measurement⁴: G/I

Institution holding remains: Arizona State Museum, University of Arizona, Tucson, AZ

Excavator (or donor) and date of excavation: Byron Cummings (1931-1939)

Description of site: Two groups of pueblo room blocks and at least two plazas were uncovered at this site. Burials were made mostly in middens and the floors of rooms.

References: Baldwin, n.d.; Jones, 1935; Mott, 1936; Cummings, 1940

14) Site number¹: AZ W:10:50

Site name: Point of Pines

Location(s): Southeast-central Arizona, along the Point of Pines Creek, on an intermountain plateau between the Salt and Gila Rivers (33.36, -109.74)

Time period(s): 665 to 500 yBP

Region: U.S. Southwest

Cultural affiliation: Western Pueblo

Subsistence²: AGR

(Point of Pines, continued)

Number of individuals observed (♂/♀/?)³: 5/5/0

Condition of remains at time of measurement⁴: G/I

Institution holding remains: Arizona State Museum, University of Arizona, Tucson, AZ

Excavator (or donor) and date of excavation: University of Arizona Archaeological Field School
(1946-1957)

Description of site: This was a single pueblo consisting of over 800 rooms, with burials located in the floors of rooms and outside of the pueblo walls.

References: Smiley, 1949; Bennett, 1973; Haury, 1989

15) Site number¹: AZ W:9:123

Site name: Turkey Creek

Location(s): Southeast-central Arizona, along the Turkey Creek, on an intermountain plateau between the Salt and Gila Rivers (33.47, -109.77)

Time period(s): 750 to 700 yBP

Region: U.S. Southwest

Cultural affiliation: Western Pueblo

Subsistence²: AGR

Number of individuals observed (♂/♀/?)³: 4/4/0

Condition of remains at time of measurement⁴: VG/NC

Institution holding remains: Arizona State Museum, University of Arizona, Tucson, AZ

Excavator (or donor) and date of excavation: University of Arizona Archaeological Field School
(1958-1960)

Description of site: A system of three structures, consisting of over 300 rooms, these were built around a single great kiva. Burials were found in midden mounds surrounding the pueblo.

References: Lowell, 1991; Tillack, 2005

ARKANSAS

16) Site number¹: 3MS78

Site name: Mississippi River Valley Sites: Pecan Point

Location(s): Northeastern Arkansas, along the Mississippi River near Nodena (35.54, -89.93)

Time period(s): ca. 400 yBP

Region: Southeastern United States

Cultural affiliation: Late Mississippian

Subsistence²: AGR

Number of individuals observed (♂/♀/?)³: 1/2/0

Condition of remains at time of measurement⁴: VG/NC

Institution holding remains: National Museum of Natural History (Smithsonian), Washington, DC

Excavator (or donor) and date of excavation: Clarence B. Moore (1910)

Description of site: Located along the Mississippi River, this site had been a Middle Mississippian mound center that was later a fortified Late Mississippian village. Moore worked at the site for two weeks and uncovered more than 300 burials and hundreds of Late Mississippian vessels.

References: Morse and Morse, 1998

17) Site number¹: 3UN13

Site name: Ouachita River Valley Sites: Boytt's Field

Location(s): Central Southern Arkansas, near to Pigeon Hill (33.28, -92.36)

Time period(s): 300 to 200 yBP

Region: Southeastern United States

Cultural affiliation: Mississippian (Caney Bayou)

Subsistence²: AGR

Number of individuals observed (♂/♀/?)³: 2/0/0

Condition of remains at time of measurement⁴: G/I

Institution holding remains: National Museum of Natural History (Smithsonian), Washington, DC

Excavator (or donor) and date of excavation: Clarence B. Moore (1908)

Description of site: The site was comprised of a eroded mound and associated midden, with over 50 burials located in the latter. Artifacts associated with the burials and found in the midden indicate a late Mississippian occupation of the site. An earlier Coles Creek phase occupation was later found at the site.

References: Weinstein et al., 2003

18) Site number¹: 3MI29

Site name: Red River Valley Sites: McClure Place

Location(s): Southwestern Arkansas, near to Garland City (33.20, -93.80)

Time period(s): ca. 400 to 200 yBP

Region: Southeastern United States

Cultural affiliation: Late Caddo

Subsistence²: AGR

Number of individuals observed (♂/♀/?)³: 0/1/0

Condition of remains at time of measurement⁴: E/C

Institution holding remains: National Museum of Natural History (Smithsonian), Washington, DC

Excavator (or donor) and date of excavation: Clarence B. Moore (1912)

Description of site: Two low mounds located on the Red River, the site was prone to flooding and only yielded two burials. Both were found with multiple ceramic vessels that associated the burials with the Late Caddo culture.

References: Weinstein et al., 2003

19) Site number¹: 3CS27, 3PO23, 3SF12, 3LW509

Site name: St. Francis & Black River Valley Sites: Rose, Potter Place, Castile Place, Lauratown

Location(s): Central northern and eastern Arkansas, along the St. Francis and Black Rivers:
Rose Mound (35.26, -90.57); Potter Place (35.55, -90.44); Castile Place (35.14, -90.65);
Lauratown (36.02, -91.09)

Time period(s): 550-400 yBP

Region: Southeastern United States

Cultural affiliation: Late Mississippian (Parkin phase)

Subsistence²: AGR

Number of individuals observed (♂/♀/?)³: 10/7/0

Condition of remains at time of measurement⁴: G/I

Institution holding remains: National Museum of Natural History (Smithsonian), Washington, DC

Excavator (or donor) and date of excavation: Clarence B. Moore (1910)

(St. Francis & Black River Valley Sites, continued)

Description of site: All of these sites were located in the floodplains of the Saint Francis and Black Rivers, and all except Lauratown were fortified and represented the terminal Mississippian period. Lauratown may have dated to before 550 yBP, though the account of this site leaves its temporal affiliation ambiguous. The Rose Mound had an earlier occupation as well, but heavy damage prevented the recovery of burials from the pre-Parkin phase area of the site useful to this study.

References: Morse and Morse, 1998

CALIFORNIA

20) Site number¹: CA-SJO-112

Site name: Bear Creek (Cecil)

Location(s): Central California near to the city of Stockton (37.94, -121.25)

Time period(s): 4000 to 3500 yBP

Region: California

Cultural affiliation: Late Early Period (unknown affiliation, possibly pre-Miwok)

Subsistence²: IH

Number of individuals observed (♂/♀/?)³: 6/6/0

Condition of remains at time of measurement⁴: G/I

Institution holding remains: University of California – Davis, Davis, CA

Excavator (or donor) and date of excavation: William Olsen (salvage) (1958)

Description of site: A cemetery site, located in an orchard and alongside the Bear Creek, the Bear Creek or Cecil site was salvaged by Olsen after a substantial portion of the site had been destroyed.

References: Olsen and Wilson, 1964; internal report, University of California – Davis

21) Site number¹: CA-SJO-68

Site name: Blossom (Goldman)

Location(s): West central California, near to the town of New Hope (38.24, -121.45)

Time period(s): 4300 to 3000 yBP

Region: California

Cultural affiliation: Early Period (Windmill)

Subsistence²: IH

Number of individuals observed (♂/♀/?)³: 20/17/2

Condition of remains at time of measurement⁴: VG/NC

Institution holding remains: Phoebe A. Hearst Museum of Anthropology, University of California – Berkeley, Berkeley, CA

Excavator (or donor) and date of excavation: R.F. Heizer (1941-1947)

Description of site: This was a small burial mound and habitation site located in the central Sacramento Valley near to the Mokelumne River.

References: Heizer, 1949; Gerow, 1991; Bartelink, 2001

22) Site number¹: None assigned

Site name: Channel Islands

Location(s): Burials located off the coast of southwestern California: Santa Rosa Island (34.00, -120.60); San Clemente Island (33.00, -118.57); San Nicholas Island (33.25, -119.50); Santa Catalina Island (33.44, -118.51); Santa Cruz Island (34.00, -119.60)

(Channel Islands, continued)

Time period(s): 5000 to 500 yBP (multiple sites and villages)

Region: California

Cultural affiliation: Various names have been assigned (Canaliño, Gabrielino, Nicoleño)

Subsistence²: MHG

Number of individuals observed (♂/♀/?)³: 11/17/0

Condition of remains at time of measurement⁴: G/I

Institution holding remains: San Diego Museum of Man, San Diego, CA

National Museum of Natural History (Smithsonian), Washington, DC

Excavator (or donor) and date of excavation: Malcolm Rogers (1930s, San Nicholas)

Phil C. Orr (1947-1950, Santa Rosa)

Spencer L. Rogers (1970s, San Clemente)

Description of site: Multiple sites found across the Channel Islands, some represented long-term occupation sites, while others were short-term nomadic habitations. As the cultural identification of the groups has traditionally separated the inhabitants of the Channel Islands into two linguistic groups, skeletons from San Nicholas Island are analyzed as a separate group from those of the northern islands.

References: Orr, 1951; Meighan and Eberhart, 1953

23) Site number¹: CA-SOL-270

Site name: Cook

Location(s): Central west California, near to Vacaville on Laguna Creek (38.36, -121.98)

Time period(s): 4000 to 2000 yBP

Region: California

Cultural affiliation: Middle Period (unknown affiliation)

Subsistence: FHG

Number of individuals observed (♂/♀/?)³: 14/4/1

Condition of remains at time of measurement⁴: G/I

Institution holding remains: University of California – Davis, Davis, CA

Excavator (or donor) and date of excavation: Betty Shutler, Thomas Chambers and Walter Brown (1963-1964)

Description of site: This was a cemetery bisected by the Laguna Creek, near to another habitation site (CA-SOL-254, the Swanson Site) that may have been associated with these burials.

References: McGonagle, 1966; internal report, University of California – Davis

24) Site number¹: None assigned

Site name: Cuyama Ranch

Location(s): South central California, near to the town of Cuyama (34.98, -119.66)

Time period(s): 1000 to 200 yBP

Region: California

Cultural affiliation: Yokut

Subsistence: IH

Number of individuals observed (♂/♀/?)³: 2/4/0

Condition of remains at time of measurement⁴: VG/NC

Institution holding remains: National Museum of Natural History (Smithsonian), Washington, DC

Excavator (or donor) and date of excavation: William D. Strong (1933-1934)

Description of site: This was a habitation site that was only surveyed by Strong. No documentation exists for artifact associations with burials, though Seltzer and Strong attribute the site to an early Yokut occupation.

References: Seltzer and Strong, 1936

25) Site number¹: CA-CCO-295

Site name: Ellis Landing (Nelson)

Location(s): West-central California, on the eastern shore of the San Francisco Bay (37.93, -122.40)

Time period(s): 5000 to 3000 yBP

Region: California

Cultural affiliation: Early Period (Windmiller/East Bay)

Subsistence: MHG

Number of individuals observed (♂/♀/?)³: 12/7/0

Condition of remains at time of measurement⁴: G/I

Institution holding remains: Phoebe A. Hearst Museum of Anthropology, University of California – Berkeley, Berkeley, CA

Excavator (or donor) and date of excavation: Nels C. Nelson (1907)

Description of site: A shell mound located on a marshy point (Point Isabel) that was once an island, the site was heavily disturbed prior to excavation. No habitation site was reported, but as a portion of the site was submerged, it could have eroded or been destroyed by modern construction.

References: Nelson, 1910; Gerow, 1991; Stewart and Praetzelis, 2003

26) Site number¹: CA-SAC-60, CA-SAC-72, CA-SAC-127

Site name: Hicks, Herzog, Augustine and other Sacramento Sites

Location(s): Northern central California, along the Sacramento River (38.43, -121.50)

Time period(s): ca. 1500 to 500 yBP

Region: California

Cultural affiliation: Transitional to Late Period (unknown affiliation)

Subsistence: IH

Number of individuals observed (♂/♀/?)³: 8/9/0

Condition of remains at time of measurement⁴: VG/NC

Institution holding remains: National Museum of Natural History (Smithsonian), Washington, DC

Excavator (or donor) and date of excavation: Robert F. Heizer (1930s)

Description of sites: These are various mounds located in the central Sacramento Valley, located on the banks of the Sacramento River. Little detail about the sites was recorded, though some (i.e., Sac-60, the Hicks Site) have been radiocarbon dated.

References: Heizer and Fenenga, 1939; Riddell and McGeein, 1969

27) Site number¹: CA-LAS-7

Site name: Karlo

Location(s): Northeastern California, near to the town of Karlo (40.55, -120.32)

Time period(s): 3000 yBP

Region: California

Cultural affiliation: Karlo Period

Subsistence: IH

Number of individuals observed (♂/♀/?)³: 2/7/0

Condition of remains at time of measurement⁴: VG/NC

Institution holding remains: Phoebe A. Hearst Museum of Anthropology, University of California – Berkeley, Berkeley, CA

Excavator (or donor) and date of excavation: Francis A. Riddell (1950s)

Description of site: Riddell described this as a single ridge containing a small burial ground and some signs of intermittent habitation. Little site description is available.

References: Riddell, 1960; Riddell and McGeein, 1969

28) Site number¹: CA-SOL-11

Site name: Jones

Location(s): Central west California, near to the city of Fairfield (38.25, -122.01)

Time period(s): 4000 to 2000 yBP

Region: California

Cultural affiliation: Middle Period (unknown affiliation, likely pre-Patwin)

Subsistence: IH

Number of individuals observed (♂/♀/?)³: 9/7/1

Condition of remains at time of measurement⁴: G/I

Institution holding remains: University of California – Davis, Davis, CA

National Museum of Natural History (Smithsonian), Washington, DC

Excavator (or donor) and date of excavation: Walter Brown and Jay Ruby (1965)

Description of site: A single habitation site located in the Green Valley, Jones was described as a site containing middens and a number of burials, as well as artifacts that place it well within the Middle Horizon Period.

References: Snoke, 1967; internal report, University of California – Davis

29) Site number¹: W-5, W-9, W-12, W-34, LC-34, LC-30, Lc-31

Site name: La Jolla

Location(s): Southwestern California and northern Baja California: W-5, W-9, W-12 sites (32.91, -117.26); W-34 (32.98, -117.27); LC-34 (32.33, -117.05); LC-30 and LC-31 (32.35, -116.95)

Time period(s): ca. 8000 to 7500 yBP (Chancellor's Site, W-12)
ca. 6000 to 2000 yBP

Region: California

Cultural affiliation: La Jollan I to III

Subsistence: MHG

Number of individuals observed (♂/♀/?)³: 11/12/2

Condition of remains at time of measurement⁴: P/F

Institution holding remains: San Diego Museum of Man, San Diego, CA

Excavator (or donor) and date of excavation: Malcolm Rogers (1920s and 1930s)

Description of site: These skeletons came from multiple sites located both north of San Diego, California, and in northern Baja California, along the coast and generally in shell mounds. Two skeletons that were from the Chancellor's Site in the La Jolla Canyon area have been dated as over 7000 yBP. Most sites demonstrated some semi-permanent habitation.

References: Rogers, 1963; Owsley, n.d.

30) Site number¹: CA-YOL-13

Site name: Mustang Mound

Location(s): Western central California, near to Knights Landing (38.78, -121.62)

Time period(s): 1800 to 600 yBP

Region: California

Cultural affiliation: Late Period (Augustine, possibly pre-Wintun)

Subsistence: FHG

Number of individuals observed (♂/♀/?)³: 10/8/0

Condition of remains at time of measurement⁴: G/I

Institution holding remains: Phoebe A. Hearst Museum of Anthropology, University of California – Berkeley, Berkeley, CA

Excavator (or donor) and date of excavation: William Olsen (1957-1958) & Alex Krieger (1958)
Martin Baumhoff (1960)

(Mustang Mound, continued)

Description of site: This was a single burial mound located along the confluence of the Sacramento and Feather Rivers. No habitation sites were reported in association with Mustang Mound.

There is evidence that the site may have been in use again after European contact.

References: Riddell, 1949; Internal report, University of California

31) Site number¹: CA-NAP-32

Site name: Napa Valley Site

Location(s): Central western California, near to Rutherford (38.46, -122.43)

Time period(s): ca. 1400 yBP

Region: California

Cultural affiliation: Late Period

Subsistence: FHG

Number of individuals observed (♂/♀/?)³: 0/1/0

Condition of remains at time of measurement⁴: VG/NC

Institution holding remains: National Museum of Natural History (Smithsonian), Washington, DC

Excavator (or donor) and date of excavation: Robert F. Heizer (1951)

Description of site: Excavations at this site were limited; no reports of habitation were recorded, though it was likely an encampment or a village.

References: Heizer and Squier, 1953

32) Site number¹: CA-SAC-151

Site name: Need 1

Location(s): Central western California, near to the town of Need (38.31, -121.33)

Time period(s): ca. 500 yBP

Region: California

Cultural affiliation: Late Period (possibly pre-Yokut)

Subsistence: IH

Number of individuals observed (♂/♀/?)³: 15/12/0

Condition of remains at time of measurement⁴: G/I

Institution holding remains: Phoebe A. Hearst Museum of Anthropology, University of California – Berkeley, Berkeley, CA

Excavator (or donor) and date of excavation: Franklin Fenenga (1947)

Description of site: Located along the western bank of the Cosumnes River in the area of Need, California, this was a small habitation and cemetery site located by a seasonal river.

References: Fenenga site report

33) Site number¹: 4PTSAL

Site name: Point Sal

Location(s): Southwestern coastal California, west of Santa Maria (34.91, -120.67)

Time period(s): 1900 to 1200 yBP

Region: California

Cultural affiliation: Transitional to Late Period (possibly pre-Chumash)

Subsistence: FHG

Number of individuals observed (♂/♀/?)³: 17/8/0

Condition of remains at time of measurement⁴: P/F

Institution holding remains: San Diego Museum of Man, San Diego, CA

Excavator (or donor) and date of excavation: George F. Carter (1930s)

(Point Sal, continued)

Description of site: A large shell midden located along a spring two miles from the coast, the site was not extensively excavated. Archaeological evidence suggested that the site had a long-term habitation or multiple occupations, though most burials were removed from the upper strata and have been dated within a limited time period relative to the potential length of occupation at the site.

References: Carter, 1941; Owsley, n.d.

34) Site number¹: CA-ALA-329

Site name: Ryan Mound

Location(s): Central west California, on the southeastern shore of the San Francisco Bay (37.57, -122.03)

Time period(s): 1400 to 500 yBP

Region: California

Cultural affiliation: Late Period (possibly pre-Yokut)

Subsistence: FHG

Number of individuals observed (♂/♀/?)³: 20/17/3

Condition of remains at time of measurement⁴: VG/NC

Institution holding remains: San Jose State University, San Jose, CA

Excavator (or donor) and date of excavation: Wedel (1935)
C.E. Smith (1948)
Bert A. Gerow (1959)
J. Hester and D. Prtichard (1962-1968)

Description of site: This was a single burial shellmound located within close proximity to at least three other mounds, with some evidence for a long period of local habitation in the region (until European contact). The mound may have once bordered on the Bay.

References: Coberly, 1973; Leventhal, 1993; Bartelink, 2001

35) Site number¹: None assigned

Site name: Tulamnui

Location(s): South central California, near the city of Taft (35.15, -119.34)

Time period(s): ca. 1000 to 200 yBP

Region: California

Cultural affiliation: Yokut

Subsistence: IH

Number of individuals observed (♂/♀/?)³: 4/2/0

Condition of remains at time of measurement⁴: G/I

Institution holding remains: National Museum of Natural History (Smithsonian), Washington, DC

Excavator (or donor) and date of excavation: William D. Strong (1933-1934)

Description of site: A shell midden and habitation site located close to the Buena Vista Lake, this site was located next to an historical village.

References: Seltzer and Strong, 1936

36) Site number¹: CA-ALA-307

Site name: Western Berkeley

Location(s): West-central California, on the northeastern San Francisco Bay (37.87, -122.28)

Time period(s): 4100 to 2800 yBP

Region: California

Cultural affiliation: Early Period (Windmillier/East Bay)

Subsistence: MHG

(Western Berkeley, continued)

Number of individuals observed (♂/♀/?)³: 7/4/0

Condition of remains at time of measurement⁴: G/I

Institution holding remains: Phoebe A. Hearst Museum of Anthropology, University of California – Berkeley, Berkeley, CA

Excavator (or donor) and date of excavation: E.L. Furlong (1902)
Joseph Peterson (1904)
E.W. Gifford (1916)
D.W. Lathrop (1950)

Description of site: A shell mound located close to the San Francisco Bay, this was a remnant of a larger mound and settlement destroyed by multiple modern construction episodes. No systematic excavation of the surrounding area was conducted, so specific evidence of habitation was not reported.

References: Peterson, 1904; Wallace and Lathrap, 1975; Gerow, 1991; Bartelink, 2001

37) Site number¹: CA-SFR-7 (and CA-SFR-17)

Site name: Yerba Buena and Bayshore Mound

Location(s): Yerba Buena is one of the San Francisco Bay islands (37.82, -122.37). Bayshore Mound was located alongside the western side of the San Francisco Bay in the southeastern area of San Francisco (37.72, -122.38)

Time period(s): ca. 3000 to 2000 yBP

Region: California

Cultural affiliation: Middle Period (unknown affiliation)

Subsistence: MHG

Number of individuals observed (♂/♀/?)³: 10/2/0

Condition of remains at time of measurement⁴: VG/NC

Institution holding remains: Phoebe A. Hearst Museum of Anthropology, University of California – Berkeley, Berkeley, CA

Excavator (or donor) and date of excavation: N.C. Nelson (1910)

Description of site: The largest of the shell mounds located in the northern aspect of the San Francisco peninsula in western central California, this mound was located in present Visitation Valley alongside the San Francisco Bay. Yerba Buena is located in the lower central area of the San Francisco Bay.

References: Nelson, 1909; Unpublished manuscripts at the Phoebe A. Hearst Museum

38) Site number¹: LC-30, LC-31, LC-34

Site name: Yuma III

Location(s): Multiple locations, most close to El Médano, Baja California (32.35, -116.95)

Time period(s): ca. 1000 to 200 yBP

Region: California

Cultural affiliation: Yuma

Subsistence: MHG

Number of individuals observed (♂/♀/?)³: 4/3/1

Condition of remains at time of measurement⁴: G/I

Institution holding remains: San Diego Museum of Man, San Diego, CA

Excavator (or donor) and date of excavation: Malcolm Rogers (1920s and 1930s)

Description of site: A slough and a cliffside in close proximity to each other in the Médano region, the sites were composed of shell mounds indicating intermittent habitation. These were the burials identified as Yuman from multi-component sites that included La Jollan skeletons.

References: Rogers, 1963; Owsley, n.d.

COLORADO

39) Site number¹: None assigned

Site name: Ackmen / Lowry Ruin

Location(s): Southwestern Colorado, close to the Utah border and the town of Pleasant View, Colorado (37.57, -108.79)

Time period(s): 860 to 660 yBP

Region: U.S. Southwest

Cultural affiliation: Ancient Pueblo (“Anasazi,” Chaco Canyon & Mesa Verde affiliations)

Subsistence: AGR

Number of individuals observed (♂/♀/?)³: 4/6/0

Condition of remains at time of measurement⁴: G/I

Institution holding remains: Field Museum of Natural History, Chicago, IL

Excavator (or donor) and date of excavation: Paul S. Martin (1930-1934)

Description of site: This was a single, large pueblo constructed in multiple stages bridging two occupation periods, with 37 identified rooms and potentially 7 kivas. The nature of internments was not described.

References: Nash et al., 2005

40) Site number¹: 5MT5

Site name: Yellow Jacket Pueblo

Location(s): Southwestern Colorado, in the Mesa Verde region (37.57, -108.79)

Time period(s): 1000 to 800 yBP

Region: U.S. Southwest

Cultural affiliation: Pueblo II to Pueblo III

Subsistence: AGR

Number of individuals observed (♂/♀/?)³: 2/1/0

Condition of remains at time of measurement⁴: VP

Institution holding remains: Utah Museum of Natural History (Univ. of Utah), Salt Lake City, UT

Excavator (or donor) and date of excavation: Unknown

Description of site: A single village that likely served as the center of a series of mostly undocumented smaller regional habitation sites, this site was located on a mesa bluff in the Mesa Verde region of southwestern Colorado. The site has apparently been disturbed by previous excavations, some professional, which would account for the three uncertainly provenanced crania located at the Utah Museum of Natural History.

References: Kuckelman, 2003

FLORIDA

41) Site number¹: None assigned

Site name: Bayshore Mounds (Lighthouse Point)

Location(s): Central western Florida peninsula coast, near to Largo (27.82, -82.76)

Time period(s): ca. 2000 yBP

Region: Southeastern United States

Cultural affiliation: Manasota (Weeden Island II)

Subsistence: MHG

Number of individuals observed (♂/♀/?)³: 7/9/1

Condition of remains at time of measurement⁴: P/F

Institution holding remains: Florida Museum of Natural History, Univ. of Florida, Gainesville, FL

(Bayshore Mounds, continued)

Excavator (or donor) and date of excavation: William H. Sears (1956-1959)

Description of site: Three mounds—two burial and one ceremonial—were located along the Boca Ciega Bay with an associated shell midden. One mound was identified as a “temple mound” due to its pyramidal shape. All skeletons used in this study came from Mound B, which was apparently used for only a brief period of time, unlike Mound C (the other burial mound), which exhibited long-term use.

References: Sears, 1960; Milanich, 1994.

42) Site number¹: 8SO18

Site name: Little Salt Spring

Location(s): Southwestern Florida peninsula, near Englewood (26.95, -82.34)

Time period(s): ca. 10000 yBP

Region: Southeastern United States

Cultural affiliation: Early Holocene pre-Archiac (“Paleoindian”)

Subsistence: FHG

Number of individuals observed (♂/♀/?)³: 1/0/0

Condition of remains at time of measurement⁴: VP

Institution holding remains: Florida Museum of Natural History, Univ. of Florida, Gainesville, FL

Excavator (or donor) and date of excavation: William R. Royal (1950s)

Carl J. Clausen (1970s)

John Gifford (1990s to present)

Description of site: A multicomponent site located within and on a ridge alongside a large sinkhole near to the Florida coast, only one very partial skeleton of a male was found in association with early Holocene artifacts (wooden stakes and lithic tools). The skeleton was dated to be from approximately 10,000 years before present. Numerous other skeletons from the late Early Archaic are also located on a ridge near to the site, though these were not examined for this study.

References: Clausen et al., 1979; Powell, 2005

43) Site number¹: 8SO2

Site name: Palmer (Village and Mound) / Casey Key

Location(s): Central western coast of the Florida peninsula, near to Osprey (27.21, -82.50)

Time period(s): 2500 to 1200 yBP

Region: Southeastern United States

Cultural affiliation: Weeden Island phase

Subsistence: MHG

Number of individuals observed (♂/♀/?)³: 22/22/1

Condition of remains at time of measurement⁴: P/F

Institution holding remains: Florida Museum of Natural History, Univ. of Florida, Gainesville, FL

Excavator (or donor) and date of excavation: Ripley P. and Adelaide K. Bullen (1959-1962)

Description of site: Located on the sand bars along the Little Sarasota Bay, this area consisted of a number of sites, demonstrating a long-term occupation of the region (from Middle Archaic to at least the end of the Weeden Island period, if not longer). Palmer Village and Mound were on the eastern side of the bay, adjacent to a shell midden. Burials were mostly placed in a burial mound, with some located on the periphery of the associated village. Casey Key Mound was located on the western side of the bay, located along a sand bar. This site was looted and only fragmentary ceramic artifacts and skeletal remains were ever uncovered.

References: Bullen and Bullen, 1976; Milanich, 1994

44) Site number¹: 8VO24

Site name: Tick Island

Location(s): Upper St. Johns River Valley, northeastern Florida peninsula (29.10, -81.44)

Time period(s): 6500 to 5000 yBP

Region: Southeastern United States

Cultural affiliation: Middle Archaic

Subsistence: FHG

Number of individuals observed (♂/♀/?)³: 3/2/0

Condition of remains at time of measurement⁴: VP

Institution holding remains: Florida Museum of Natural History, Univ. of Florida, Gainesville, FL

Excavator (or donor) and date of excavation: Clarence B. Moore (1891-1893)

Ripley P. Bullen (1959-1961)

Otton L. Jahn (1964-1968)

Description of site: Located between Lakes Dexter and Woodruff, the site was located on a wooded and marsh island in the St. Johns River. Two shell mounds, a midden and a cemetery site were located on the island; one mound was disturbed by commercial shell mining. Middle Archaic burials were located within these shell mounds and the midden, where calcium carbonate concretions leached into the sandy soil and formed a cement that continues to bind multiple skeletons together, deforming elements and making individual measurements difficult on post-crania.

References: Jahn and Bullen, 1978; Milanich, 1994; Powell, 1995; Cabanilla, 1999

45) Site number¹: 8SO19

Site name: Warm Mineral Springs

Location(s): Central western Florida near to Charlotte Harbor (27.06, -82.26)

Time period(s): ca. 10,000 yBP; some remains may be much more recent (8000 – 2000 yBP)

Region: Southeastern United States

Cultural affiliation: Early Holocene pre-Archaic (“Paleoindian”), Windover Archaic?

Subsistence: FHG

Number of individuals observed (♂/♀/?)³: 2/1/>10 (association of remains difficult)

Condition of remains at time of measurement⁴: VP

Institution holding remains: Florida Museum of Natural History, Univ. of Florida, Gainesville, FL

Excavator (or donor) and date of excavation: H.K. Brooks (1958-1962)

William R. Royal (1960-1970s)

Carl J. Clausen (1970s)

Description of site: A sinkhole that likely formed due to the collapse of a limestone cavern, the site consists of two ledges 4 and 13 meters below the water surface, with human remains found at multiple levels of the spring. The relative provenance of the skeletal remains is not well defined, though most were recovered from the 13-meter ledge. Some skeletal elements date to the early Holocene, though some are much more recent. Identification of the various antiquities of the remains are uncertain, though recent analysis suggests that the cranial remains from this site most closely resemble those from the Windover site.

References: Clausen et al., 1975; Antón et al., 2000; Powell, 2005

46) Site number¹: 8BR246

Site name: Windover Pond

Location(s): Central east coast of the Florida peninsula, near Cape Canaveral (28.62, -80.82)

Time period(s): ca. 8100 yBP

Region: Southeastern United States

Cultural affiliation: Early Archaic (Windover Archaic)

Subsistence: FHG

(Windover Pond, continued)

Number of individuals observed (♂/♀/?)³: 43/28/3

Condition of remains at time of measurement⁴: G/I

Institution holding remains: Florida State University, Tallahassee, FL

Excavator (or donor) and date of excavation: Glen Doran (1982-1986)

Description of site: Perhaps the most unique excavated cemetery in North America, this site consists of a single large pond into which more than 200 individuals were buried in its peat bottom. Burials were held in place with long wooden stakes, and preservation at the site allowed the retention of wooden and other perishable materials, in addition to soft tissue on the skeletons (including brain tissue from many individuals). Skeletal variation implies two groups used the pond, though genetic analyses indicate that these were part of a single population.

References: Doran and Dickel, 1988a, 1988b; Hauswirth et al., 1991; Milanich, 1994; Doran, 2002; Powell, 2005; Stojanowski et al., 2006

GEORGIA

47) Site number¹: 9CH1

Site name: Irene Mound

Location(s): Near the termination of the Savannah River into the Atlantic Ocean in southeastern Georgia, northwest of Savannah (32.13, -81.15)

Time period(s): ca. 650 to 250 yBP

Region: Southeastern United States

Cultural affiliation: Savannah and Irene cultures

Subsistence: AGR

Number of individuals observed (♂/♀/?)³: 13/19/0

Condition of remains at time of measurement⁴: G/I

Institution holding remains: National Museum of Natural History (Smithsonian), Washington, DC

Excavator (or donor) and date of excavation: Clarence B. Moore (1897)

Joseph Caldwell, Claude E. Shaeffer,

Vladimir Fewkes, Preston Holder (1937-1939)

Description of site: This was a ceremonial mound, burial mound, and cluster of habitations located on the southwestern bluffs along the Savannah River. This site was occupied at least as early as the Savannah phase, and was still occupied during European contact.

References: Larsen, 1982

ILLINOIS

48) Site number¹: Wt-1

Site name: Albany

Location(s): East bank of the Mississippi River in Northwestern Illinois, near to the city of Albany (41.79, -90.21)

Time period(s): 2000 to 1800 yBP

Region: Prairie and Eastern Woodlands

Cultural affiliation: Middle Woodland (Middle Hopewell)

Subsistence: IH

Number of individuals observed (♂/♀/?)³: 11/7/1

Condition of remains at time of measurement⁴: G/I

Institution holding remains: Illinois State Museum, Springfield, IL

(Albany, continued)

Excavator (or donor) and date of excavation: William B. Nickerson (1908)

Description of site: A series of mounds (5 sampled: 9, 12, 14, 17 and 20) located along the eastern bluffs of the upper Mississippi in Illinois, located among three known archaeological villages.

References: Herold, 1971

49) Site number¹: None assigned

Site name: Calhoun County

Location(s): Western-central Illinois near to the village of Mozier (39.29, -90.73)

Time period(s): 2000 to 1000 yBP

Region: Prairie and Eastern Woodlands

Cultural affiliation: Middle and Late Woodland (Hopewellian)

Subsistence: IH

Number of individuals observed (♂/♀/?)³: 12/5/0

Condition of remains at time of measurement⁴: VG/NC

Institution holding remains: National Museum of Natural History (Smithsonian), Washington, DC

Excavator (or donor) and date of excavation: P. F. Titterington (1930-1943)

Description of site: Most skeletons are from the C.A. Knight Mound Group, a group of bluff-top mounds located on the border of the eastern floodplain of the Mississippi River. No habitation sites were reported in conjunction with these burial mounds.

References: Smithsonian museum archive notes

50) Site number¹: F-34

Site name: Dickson

Location(s): At the confluence of the Spoon and Illinois Rivers in west-central Illinois, near to Lewistown (40.38, -90.13)

Time period(s): 700 to 600 yBP

Region: Prairie and Eastern Woodlands

Cultural affiliation: Mississippian (contemporary with Cahokia)

Subsistence: AGR

Number of individuals observed (♂/♀/?)³: 26/27/0

Condition of remains at time of measurement⁴: VG/NC

Institution holding remains: Illinois State Museum, Springfield, IL

Excavator (or donor) and date of excavation: Don F. Dickson (1920s); Fay-Cooper Cole (1930s)

Description of site: A series of burial mounds constructed on bluffs above a river floodplain, adjacent to a village site (Eveland) from the Mississippian Acculturated Late Woodland period, and near to another village (Myer) and a ceremonial complex (Larson) from the Mississippian period.

References: Lallo, 1973; Harn, 1980

51) Site number¹: None assigned

Site name: Elizabeth

Location(s): Western bank of the Illinois River in west-central Illinois (39.68, -90.66)

Time period(s): 2000 yBP

Region: Prairie and Eastern Woodlands

Cultural affiliation: Middle Woodland (Middle Hopewell)

Subsistence: IH

Number of individuals observed (♂/♀/?)³: 5/3/0

Condition of remains at time of measurement⁴: G/I

(Elizabeth, continued)

Institution holding remains: Illinois State Museum, Springfield, IL

Excavator (or donor) and date of excavation: Douglas K. Charles and Jane E. Buikstra
(1979-1985)

Description of site: These were a series of burial mounds constructed on a series of knolls and bluffs just north of the Napoleon Hollow, of which three were sampled (mounds 1, 3 and 7). The site was apparently used only for mortuary and/or ceremonial purposes.

References: Charles et al., 1988

52) Site number¹: None assigned

Site name: Fulton County

Location(s): West-central Illinois, near to the town of Bath (40.23, -90.16)

Time period(s): ca. 1200 yBP

Region: Prairie and Eastern Woodlands

Cultural affiliation: Late Woodland (Hopewellian)

Subsistence: IH

Number of individuals observed (♂/♀/?)³: 1/1/0

Condition of remains at time of measurement⁴: VG/NC

Institution holding remains: National Museum of Natural History (Smithsonian), Washington, DC

Excavator (or donor) and date of excavation: Dan Morse (1960)

Rod Hiles (amateur) (1960)

Description of site: This was an archaeological cemetery located on the slope of a bluff on the western side of the Illinois River. A number of burials were found at the site, but only two were sent to the NMNH. Artifacts at the site indicated a Late Woodland occupation with some later Mississippian intrusion burials into mounds.

References: Griffin and Morse, 1961

53) Site number¹: None assigned

Site name: Jersey County

Location(s): Western-central Illinois near to the village of Nutwood (39.08, -90.57)

Time period(s): 2000 to 1000 yBP

Region: Prairie and Eastern Woodlands

Cultural affiliation: Middle to Late Woodland

Subsistence: IH

Number of individuals observed (♂/♀/?)³: 21/12/0

Condition of remains at time of measurement⁴: VG/NC

Institution holding remains: National Museum of Natural History (Smithsonian), Washington, DC

Excavator (or donor) and date of excavation: P. F. Titterington (1930-1943)

Description of site: Multiple mounds, some ceremonial without burials, these were located on bluffs to the east of the Illinois River near its confluence with the Mississippi, along the Otter Creek. Interspersed among the mounds were at least three archaeological villages located in floodplain.

References: Titterington, 1935; McKern and Titterington, 1943

54) Site number¹: 11-AD-28

Site name: Kuhlman

Location(s): West-central Illinois, near to the city of Quincy (39.88, -91.44)

Time period(s): 1300 to 1000 yBP

Region: Prairie and Eastern Woodlands

Cultural affiliation: Late Woodland (Yokem phase)

(Kuhlman, continued)

Subsistence: IH

Number of individuals observed (♂/♀/?)³: 8/6/0

Condition of remains at time of measurement⁴: VG/NC

Institution holding remains: Illinois State Museum, Springfield, IL

Excavator (or donor) and date of excavation: Jane E. Buikstra, Karen Atwell & Keith E. Condon
(1979-1981)

Description of site: These were a group of five mounds and a ridge burial ground located on bluffs to the east of the Mississippi River and southwest to an archaeological village on a plateau.

References: Atwell and Conner, 1991

55) Site number¹: Ra^s501

Site name: Modoc Rock Shelter

Location(s): Southwestern Illinois, west of the town of Modoc (38.05, -90.04)

Time period(s): 5000 to 3000 yBP

Region: Prairie and Eastern Woodlands

Cultural affiliation: Archaic (likely multiple occupations)

Subsistence: FHG

Number of individuals observed (♂/♀/?)³: 7/10/0

Condition of remains at time of measurement⁴: G/I

Institution holding remains: Illinois State Museum, Springfield, IL

Excavator (or donor) and date of excavation: Melvin L. Fowler (1952-1957)

Description of site: On the edge of the eastern Mississippi River floodplain, the site was located on a sandstone bluff under a overhang. Multiple strata, dating between 10,000 yBP and 2500 yBP, indicate multiple occupation episodes and long-term occupation of this region by humans.

References: Fowler, 1959

56) Site number¹: None assigned

Site name: St. Clair County

Location(s): West-central Illinois, among the mounds at Cahokia (38.57, -90.19)

Time period(s): ca. 1800 to 1000 yBP

Region: Prairie and Eastern Woodlands

Cultural affiliation: Middle Woodland (Hopewell)

Subsistence: IH

Number of individuals observed (♂/♀/?)³: 1/0/0

Condition of remains at time of measurement⁴: G/I

Institution holding remains: National Museum of Natural History (Smithsonian), Washington, DC

Excavator (or donor) and date of excavation: P. F. Titterington (1930-1935)

Description of site: No site description, other than location, was given.

References: Stewart and Titterington, 1944

57) Site number¹: Wh-6

Site name: Wilson

Location(s): Southeastern Illinois (western bank of the Wabash River), near to Carmi (37.90, -88.03)

Time period(s): ca. 2000 yBP

Region: Prairie and Eastern Woodlands

Cultural affiliation: Middle Woodland (Hopewell)

Subsistence: IH

Number of individuals observed (♂/♀/?)³: 6/2/0

(Wilson, continued)

Condition of remains at time of measurement⁴: G/I

Institution holding remains: Illinois State Museum, Springfield, IL

Excavator (or donor) and date of excavation: Melvin L. Fowler (1950-1951)

Description of site: A dozen burial mounds located on bluffs on the western side of the Wabash River, of which one mound (number 6) was sampled. No associated villages were reported with this site.

References: Fowler, 1951

KENTUCKY

58) Site number¹: 15OH2

Site name: Indian Knoll

Location(s): Central western Kentucky, along the upper Green River (37.27, -86.98)

Time period(s): 5500 to 3700 yBP

Region: Southeastern United States

Cultural affiliation: Middle Archaic / Shell Mound Archaic (fisher-gatherer-hunter culture)

Subsistence: FHG

Number of individuals observed (♂/♀/?)³: 29/29/3

Condition of remains at time of measurement⁴: E/C

Institution holding remains: W.S. Webb Museum, University of Kentucky, Lexington, KY

Excavator (or donor) and date of excavation: Clarence B. Moore (1915-1916)

William S. Webb (1939-1943)

Description of site: This was a large shell mound located on a crest alongside the upper Green River, consisting of a variable habitation site (described as a “village” by Webb) and cemetery that varied in size and shape as the underlying shell mound changed. The site was likely inhabited for some time before and after the Middle Archaic period (perhaps as late as the Mississippian period) from which the skeletons used in this study were selected.

References: Webb, 1946; Snow, 1948; Herrmann, 2002

LOUISIANA

59) Site number¹: 16AV39

Site name: Brouillette

Location(s): Central Louisiana, along the Red River (31.10, -91.99)

Time period(s): 2000 to 1600 yBP

Region: Southeastern United States

Cultural affiliation: Marksville period (Middle Woodland)

Subsistence: IH

Number of individuals observed (♂/♀/?)³: 3/0/0

Condition of remains at time of measurement⁴: VP

Institution holding remains: National Museum of Natural History (Smithsonian), Washington, DC

Excavator (or donor) and date of excavation: Clarence B. Moore (1913)

(Brouillette, continued)

Description of site: Two “pyramidal” mounds located at the confluence of the L’Eau Noire Bayou and the Red River, these mounds were still prominent when Moore encountered them, in addition to the remains of a third mound. The mound Moore excavated thoroughly yielded over three dozen burials, though the scant associated artifacts provided only enough evidence to generally date the site. Some more recent excavations have indicated longer-term occupation of the site to the early Mississippian phase.

References: Hrdlička, 1909; Weinstein et al., 2003

60) Site number¹: 16CD12

Site name: Glassell Plantation/Pickett Landing

Location(s): Northwestern Louisiana, adjacent to the Red River (32.48, -93.80)

Time period(s): 550 to 250 yBP

Region: Southeastern United States

Cultural affiliation: Early Caddo (Gahagan phase)

Subsistence: AGR

Number of individuals observed (♂/♀/?)³: 0/1/0

Condition of remains at time of measurement⁴: VG/NC

Institution holding remains: National Museum of Natural History (Smithsonian), Washington, DC

Excavator (or donor) and date of excavation: Clarence B. Moore (1911)

Charles H. Webb (1959-1961)

Description of site: This site consisted of nine mounds in an elliptical pattern, containing late pre-Caddoan burials and Gahagan phase Caddoan burials. C.B. Moore visited the site in 1911, but did not encounter any burials. Webb’s return to the site was more productive, yielding not only skeletons and associated artifacts, but bows, logs, mats, and other organic artifacts.

References: Weinstein et al., 2003

61) Site number¹: 16CA7/13

Site name: Harrelson Landing

Location(s): Northwestern Louisiana, in the Caldwell Parish Ouachita Valley (32.09, -92.06)

Time period(s): ca. 1550 to 1400 yBP

Region: Southeastern United States

Cultural affiliation: Troyville phase (Baytown period)

Subsistence: IH

Number of individuals observed (♂/♀/?)³: 0/1/0

Condition of remains at time of measurement⁴: G/I

Institution holding remains: National Museum of Natural History (Smithsonian), Washington, DC

Excavator (or donor) and date of excavation: Clarence B. Moore (1908)

Description of site: Three mounds constructed on a natural levee at the confluence of the Sandy Bayou and Ouachita River, the site consisted of eight burials and midden. Ceramics and lithics located at the site were used by Gibson as type artifacts for the designation of the first phase of the Baytown period. Only one skeleton was still intact enough to be included at the time of study.

References: Hrdlička, 1909; Weinstein et al., 2003

62) Site number¹: 16FR140/220

Site name: Jones Landing

Location(s): Northeastern Louisiana, at the confluence of Turkey Creek and the Boeuf River (31.88, -91.78)

Time period(s): 700 to 400 yBP

(Jones Landing, continued)

Region: Southeastern United States

Cultural affiliation: Plaquemine period

Subsistence: AGR

Number of individuals observed (♂/♀/?)³: 1/1/0

Condition of remains at time of measurement⁴: VP

Institution holding remains: National Museum of Natural History (Smithsonian), Washington, DC

Excavator (or donor) and date of excavation: Clarence B. Moore (1909)

Description of site: The site was located on a landing adjacent to a plantation, and consisted of two mounds and a midden. One mound was disturbed by the construction of a house, but the second contained two burials and crania. Artifacts found in the second mound and adjacent plantation were associated with the Plaquemine (Early Mississippian) period.

References: Hrdlička, 1913; Weinstein et al., 2003

63) Site number¹: 16OU17

Site name: Myatts Landing

Location(s): North Central Louisiana, at the confluence of Cheniere Creek and the Ouachita River (32.40, -92.06)

Time period(s): ca. 750 to 300 yBP

Region: Southeastern United States

Cultural affiliation: Plaquemine and early Mississippian

Subsistence: AGR

Number of individuals observed (♂/♀/?)³: 3/3/0

Condition of remains at time of measurement⁴: G/I

Institution holding remains: National Museum of Natural History (Smithsonian), Washington, DC

Excavator (or donor) and date of excavation: Clarence B. Moore (1909)

Description of site: A midden located on a rise on a plantation near the Ouachita River, the site contained a recent cemetery and evidence of long-term occupation of the site (as many as 1500 years). Skeletons were associated with late Plaquemine and early Mississippian artifacts—namely pottery—and were recovered from the upper layers of the strata at the site.

References: Hrdlička, 1909; Weinstein et al., 2003

64) Site number¹: None assigned

Site name: Sorrel Bayou Mound

Location(s): Central southern Louisiana, in Sorrel Bayou (30.16, -91.33)

Time period(s): 700 to 500 yBP

Region: Southeastern United States

Cultural affiliation: Middle Mississippian

Subsistence: AGR

Number of individuals observed (♂/♀/?)³: 3/2/0

Condition of remains at time of measurement⁴: VP

Institution holding remains: National Museum of Natural History (Smithsonian), Washington, DC

Excavator (or donor) and date of excavation: Clarence B. Moore (1912)

Description of site: A burial mound, including both primary and secondary burials, this was located close to the confluence of the Sorrel Bayou and the Grand River. Burials were uncovered from an earthen “platform” surrounding the mound, as contemporary European burials had been placed into the undoubtedly archaeological mound and Moore did not want to disturb these more recent inhumations.

References: Hrdlička, 1909; Weinstein et al., 2003

65) Site number¹: 16MO12, 16MO11

Site name: Ward Place and Bray Landing

Location(s): Central northern Louisiana, along the Ouachita River (32.61, -91.80)

Time period(s): 400 to 200 yBP

Region: Southeastern United States

Cultural affiliation: Late Mississippian period (Kinnaird and Glendora phases)

Subsistence: AGR

Number of individuals observed (♂/♀/?)³: 8/7/0

Condition of remains at time of measurement⁴: G/I

Institution holding remains: National Museum of Natural History (Smithsonian), Washington, DC

Excavator (or donor) and date of excavation: Clarence B. Moore (1909)

Description of site: The exact locations of these two sites have been lost, though they were in Morehouse Parish along the Ouachita River. Both sites were small mounds containing over three dozen burials, abundant with associated artifacts that associated the Ward Place site with the Glendora phase and the Bay Landing site with the Kinnaird phase.

References: Hrdlička, 1909; Weinstein et al., 2003

MAINE

66) Site number¹: None assigned

Site name: Southeastern Maine

Location(s): Boothbay (43.88, -69.64), Damariscotta (44.03, -69.52), Vinalhaven (44.05, -68.83)

Time period(s): ca. 800 to 400 yBP (dating is relative and somewhat uncertain)

Region: Prairie and Eastern Woodlands

Cultural affiliation: Algonquin (?)

Subsistence: AGR

Number of individuals observed (♂/♀/?)³: 8/5/0

Condition of remains at time of measurement⁴: P/F

Institution holding remains: Harvard University Peabody Museum of Archaeology and Ethnology, Cambridge, MA

Excavator (or donor) and date of excavation: Charles C. Willoughby (1894-1896)

Description of site: The skeletons were mostly encountered through erosion and construction, and only occasionally were excavated professionally. Some were also donated without any documentation other than basic provenience. Skeletons encountered in Damariscotta were described as having red ochre burial pit linings, in addition to numerous artifacts that most likely date to the recent pre-contact period (Penobscot or Etchemin). Shell middens dating within the last 2000 years are found throughout southeastern Maine, though none preserve bone older than 1000 years before present. Between Willoughby's report, available cultural evidence, and more recent archaeological investigation in the region, the time period of these skeletons may be conjectured.

References: Willoughby, 1898

MASSACHUSETTS

67) Site number¹: None assigned

Site name: Western Cape Cod Bay Area

Location(s): Various locations along the western portion of Cape Cod Bay, including Winthrop (42.37, -70.99), Marblehead (42.50, -70.86), Essex (42.64, -70.79), Osterville (41.63, -70.39), and Salem (42.52, -70.89)

(Western Cape Cod Bay Area, continued)

Time period(s): ca. 450 to 350 yBP

Region: Prairie and Eastern Woodlands

Cultural affiliation: Algonquin (Proto-historic period)

Subsistence: AGR

Number of individuals observed (♂/♀/?)³: 13/13/0

Condition of remains at time of measurement⁴: G/I

Institution holding remains: Harvard University Peabody Museum of Archaeology and Ethnology, Cambridge, MA

Excavator (or donor) and date of excavation: Frederick Putnam (1888-1890)

Description of site: Most burials were encountered during construction or due to erosion around the bay, and so little documentation was produced or organized archaeological investigation conducted. Many are reported in association with shell artifacts and midden. Only the skeletons from Winthrop were reported in publication, and associated funerary objects and artifacts securely dated them to the proto-historic period. Willoughby commented in his report that skeletons had been encountered rarely in Massachusetts, despite active development and long-term agriculture, and that few were uncovered with artifacts.

References: Willoughby, 1924; internal documentation at the Peabody Museum

NEVADA

68) Site number¹: 26WA?

Site name: Duck Flat

Location(s): Northwestern Nevada, near Gerlach (41.08, -119.92)

Time period(s): Not dated, possibly 1000 yBP

Region: Great Basin

Cultural affiliation: Late Archaic?

Subsistence: BSHG

Number of individuals observed (♂/♀/?)³: 1/0/0

Condition of remains at time of measurement⁴: P/F

Institution holding remains: Nevada State Museum, Carson City, NV

Excavator (or donor) and date of excavation: Unknown

Description of site: This is an isolated burial located in the Duck Flat; little documentation exists to accompany this skeleton.

References: Internal documentation at the Nevada State Museum

69) Site number¹: 26PE3E

Site name: Fishbone Cave

Location(s): Central western Nevada, eastern “shore” of Lake Winnemucca (40.12, -119.31)

Time period(s): ca. 2500 yBP

Region: Great Basin

Cultural affiliation: Great Basin Middle Archaic

Subsistence: BSHG

Number of individuals observed (♂/♀/?)³: 0/1/0

Condition of remains at time of measurement⁴: P/F

Institution holding remains: Nevada State Museum, Carson City, NV

Excavator (or donor) and date of excavation: Orr Calhoun (1954)

(Fishbone Cave, continued)

Description of site: The cave is one of three along the central eastern border of the now-dry Winnemucca Lake, and contained two burials as well as the remains of camels and horses. The skeleton examined for this study has been naturally mummified, and is still mostly intact. Radiocarbon dating, textiles and basketry associated with the burial associate it with the Middle Archaic period. The other burial dated to the pre-Archaic period (ca. 11,000 yBP), but only constituted very fragmentary human remains in association with the horse and camel bones.

References: Internal documentation at the Nevada State Museum; Tuohy and Dansie, 1997

70) Site number¹: 26CH1C

Site name: Grimes Point

Location(s): Western central Nevada, near to Grimes Point (39.41, 118.62)

Time period(s): ca. 9700 yBP

Region: Great Basin

Cultural affiliation: Early Holocene pre-Archaic ("Paleoindian")

Subsistence: BSHG

Number of individuals observed (♂/♀/?)³: 0/0/1

Condition of remains at time of measurement⁴: VP

Institution holding remains: Nevada State Museum, Carson City, NV

Excavator (or donor) and date of excavation: Sydney M. Wheeler (1940s)

Description of site: A shelter located on the banks of the extinct Lake Lahontan, this juvenile skeleton was uncovered by guano miners and given to Margaret Wheat, who then turned over the bones and associated textile (diamond-plaited matting similar to that found with Spirit Cave) to Sydney Wheeler. No additional remains were found at the site, and the disturbed nature of the shelter from miners made reconstruction of the original burial impossible.

References: Dansie, 1997; Tuohy and Dansie, 1997; Wheeler, 1997

71) Site number¹: 26PE10

Site name: Brinkerhoff Ranch (Humboldt Sink)

Location(s): Western central Nevada, near to the Humboldt Sink (40.22, -118.90)

Time period(s): ca. 200 yBP

Region: Great Basin

Cultural affiliation: Late Archaic (?)

Subsistence: IH

Number of individuals observed (♂/♀/?)³: 2/1/1

Condition of remains at time of measurement⁴: P/F

Institution holding remains: Nevada State Museum, Carson City, NV

Excavator (or donor) and date of excavation: Phil C. Orr (1950s)

Description of site: Little documentation exists for this site, though evidence from the skeletons suggests that these individuals were buried after a massacre; one skeleton exhibited signs of decapitation, and all bore cutmarks. Artifacts associated with the burials, in addition to radiocarbon dates, place these individuals within the period of European contact.

References: Internal documentation at the Nevada State Museum

72) Site number¹: 26WA3051

Site name: John Dryden Cave

Location(s): Northwestern Nevada, in the Smoke Creek Desert (40.47, -119.74)

Time period(s): ca. 2700 yBP and ca. 1600 yBP

Region: Great Basin

(John Dryden Cave, continued)

Cultural affiliation: Great Basin Middle Archaic (Gatecliff, Elko, and Pinto Barbed Series)

Subsistence: BSHG

Number of individuals observed (♂/♀/?)³: 1/0/1

Condition of remains at time of measurement⁴: VP

Institution holding remains: Nevada State Museum, Carson City, NV

Excavator (or donor) and date of excavation: L.S. Kobori (1983-1984)

Description of site: A rockshelter located in the Smoke Creek Desert northwest of Pyramid Lake, this site yielded two skeletons, dating from the beginning and the ending of the Middle Archaic period. One skeleton exhibited carnivore tooth marks, and both had associated lithic points. Only the cranium of the late-adolescent juvenile was observed, despite fairly complete post-crania.

References: Kobori, 1985

73) Site number¹: 26CH18

Site name: Lovelock Cave

Location(s): Western central Nevada, near to Fallon and Grimes Point (39.41, 118.62)

Time period(s): ca. 1700 yBP

Region: Great Basin

Cultural affiliation: Great Basin Middle Archaic

Subsistence: BSHG

Number of individuals observed (♂/♀/?)³: 1/0/0

Condition of remains at time of measurement⁴: P/F

Institution holding remains: Nevada State Museum, Carson City, NV

Excavator (or donor) and date of excavation: Sydney M. Wheeler (1940s)

Description of site: Artifacts and human remains were first found by guano miners at this cave in the 1910s. Subsequent excavation revealed a long occupation period for the site; some cultural materials became type artifacts for the Lovelock Culture. Multiple burials were also found at the site; the remains examined for this study came from a single, fragmentary burial dated to the Middle Archaic.

References: Internal documentation at the Nevada State Museum; Ferguson, 1996

74) Site number¹: 26CH1F

Site name: Spirit Cave

Location(s): Western central Nevada, near to Grimes Point (39.41, 118.62)

Time period(s): ca. 9500 yBP

Region: Great Basin

Cultural affiliation: Early Holocene pre-Archaic ("Paleoindian")

Subsistence: BSHG

Number of individuals observed (♂/♀/?)³: 1/0/0

Condition of remains at time of measurement⁴: E/C

Institution holding remains: Nevada State Museum, Carson City, NV

Excavator (or donor) and date of excavation: Sydney M. Wheeler (1940)

Description of site: A shelter located on the banks of the extinct Lake Lahontan, wherein at least two bundled burials and two cremations had been placed in the early Holocene. Spirit Cave was buried in a diamond-plaited textile mat, atop a rabbit-skin fur, and placed into a shallow grave within the cave. Another burial (Burial #1) was later placed above this burial, though the bones were never retrieved for study.

References: Dansie, 1997; Edgar, 1997; Jantz and Owsley, 1997; Tuohy and Dansie, 1997; Wheeler, 1997; Barker et al., 2000; Powell, 2005

75) Site number¹: 26PE3A-C

Site name: Winnemucca Lake: Crypt Cave, Cowbone Cave, Chimney Cave

Location(s): Central western Nevada, eastern “shore” of Lake Winnemucca (40.11, -119.31)

Time period(s): ca. 6000 yBP, ca. 3200 yBP, ca. 2400 yBP

Region: Great Basin

Cultural affiliation: Great Basin Early and Middle Archaic

Subsistence: BSHG

Number of individuals observed (♂/♀/?)³: 4/3/0

Condition of remains at time of measurement⁴: P/F

Institution holding remains: Nevada State Museum, Carson City, NV

Excavator (or donor) and date of excavation: Phil C. Orr (1950s)

Description of site: These skeletons all are associated with the Guano Caves on the eastern edge of the now-dry Winnemucca Lake. Crypt Cave (PE3A) was trenched by Orr and yielded three burials, of which two—one of which was naturally mummified and both of which dated to ca. 2400 yBP—were included in this study. Three skeletons from Chimney Cave (PE3B)—a small shelter that had been formed by wave-action erosion—were examined; all were mummified in varying states of preservation and dated to ca. 3200 yBP. The two burials from Crypt Cave, which was actually a shallow rock shelter, were fragmentary (though Orr reported more complete burials than those present at the time of observation), and dated to ca. 6000 yBP.

References: Internal documentation at the Nevada State Museum; Orr, 1952; Dansie, 1969

NEW JERSEY

76) Site number¹: None assigned

Site name: Montague

Location(s): Northwestern New Jersey, just south of the city of Montague (41.28, -74.78)

Time period(s): 500 to 400 yBP

Region: Prairie and Eastern Woodlands

Cultural affiliation: Lenape (Munsee tribe, though with Shawnee influx?)

Subsistence: AGR

Number of individuals observed (♂/♀/?)³: 10/11/0

Condition of remains at time of measurement⁴: E/C

Institution holding remains: National Museum of Natural History (Smithsonian), Washington, DC

Excavator (or donor) and date of excavation: George G. Heye (1914)

Description of site: Hrdlička described the site as a small mound located on the eastern floodplain of the Delaware River. In his monograph on the site (Hrdlička, 1916), he hypothesizes that the skeletons represent two groups: the local Munsee and an influx of Shawnee. Funerary objects were not discussed in this monograph, so the source of any intra-cemetery variation remains conjectural.

References: Hrdlička, 1916

NEW MEXICO

77) Site number¹: 29SJ395, 29SJ396

Site name: Chaco Canyon Sites: BC 51, BC 53 (Roberts' Site), BC 63

Location(s): Northwestern New Mexico, within Chaco Canyon (36.07, -107.97)

Time period(s): 1000 to 900 yBP

Region: U.S. Southwest

(Chaco Canyon, continued)

Cultural affiliation: Pueblo II and early Pueblo III (Chaco culture)

Subsistence: AGR

Number of individuals observed (♂/♀/?):³ 5/6/1

Condition of remains at time of measurement⁴: G/I

Institution holding remains: Maxwell Museum of Anthropology (University of New Mexico),
Albuquerque, NM

Excavator (or donor) and date of excavation: Clyde Kluckhohn (1930s)
Bureau of Land Management archaeologists

Description of site: A series of small pueblos located along the cliffsides of the Chaco Canyon yielded the majority of the skeletons included in this sample. All date from the period of the Chaco culture, which also included individuals from Pueblo Bonito.

References: Kluckhohn and Reiter, 1939; Stanislawski, 1963; Brock and Ruff, 1988;
Lister and Lister, 2004

78) Site number¹: LA 22765

Site name: Chamisal

Location(s): West central New Mexico, near Albuquerque (35.08, -106.66)

Time period(s): ca. 600 to 400 yBP

Region: U.S. Southwest

Cultural affiliation: Pueblo IV

Subsistence: AGR

Number of individuals observed (♂/♀/?):³ 2/5/1

Condition of remains at time of measurement⁴: G/I

Institution holding remains: Maxwell Museum of Anthropology (University of New Mexico),
Albuquerque, NM

Excavator (or donor) and date of excavation: Katherine Sargeant (1990s and 2000s)

Description of site: Uncovered in the backyard of a house, the plaza for this pueblo was excavated recently and has not yet been fully described. Pottery discovered in the excavation indicated that this site was occupied during the late Pueblo IV period.

References: Maxwell Museum internal reports

79) Site number¹: LA ?

Site name: Gallina Springs

Location(s): Southwestern central New Mexico, near to Magdalena (34.11, -107.24)

Time period(s): 800 to 500 yBP

Region: U.S. Southwest

Cultural affiliation: Late Pueblo III to Early Pueblo IV

Subsistence: AGR

Number of individuals observed (♂/♀/?):³ 7/4/1

Condition of remains at time of measurement⁴: G/I

Institution holding remains: Maxwell Museum of Anthropology (University of New Mexico),
Albuquerque, NM

Excavator (or donor) and date of excavation: Ernestene Green (1974)

Description of site: A 500 room pueblo located in central western New Mexico, the Gallina Springs site represents a transitional habitation near the end of the pre-contact Pueblo era. Little information has been recorded about the site, though burials evidently came from within the Pueblo (as the surrounding area was not systematically excavated).

References: Keller, 1976

80) Site number¹: None assigned

Site name: Hawikuh

Location(s): Central western New Mexico, near to the village of Zuñi (35.07, -108.84)

Time period(s): 500 to 300 yBP

Region: U.S. Southwest

Cultural affiliation: Pueblo IV and early post-contact

Subsistence: AGR

Number of individuals observed (♂/♀/?)³: 24/39/0

Condition of remains at time of measurement⁴: VG/NC

Institution holding remains: National Museum of Natural History (Smithsonian), Washington, DC

Excavator (or donor) and date of excavation: Frederick W. Hodge (1917-1923)

Description of site: Located on a natural terrace in the Zuñi river valley, the site was composed of a set of at least six room blocks constructed at various periods during the occupation of the ridge. After Spanish contact in the late 16th century, a monastery and a mission church were constructed at the site, which was abandoned in 1680. The majority of burials were excavated from middens on the periphery of the house groups, though some were found within the floors of rooms. All skeletons used in this study were from the pre-contact period.

References: Smith et al., 1966; Elliott, 1995

81) Site number¹: AZ Y:4:35, LA 635, LA 676, AZ Z:5:112, AZ Z:5:80

Site name: Mimbres: Bradsby, Galaz Ruin, Mattocks, Montoya, Walsh Sites

Location(s): Southwestern New Mexico, along the Mimbres River: Bradsby (32.89, -107.99);
Mattocks and Galaz (32.82, -107.95); Montoya (32.63, -107.88); Walsh (32.48, -107.95)

Time period(s): 1000 to 800 yBP

Region: U.S. Southwest

Cultural affiliation: Classic Mimbres

Subsistence: AGR

Number of individuals observed (♂/♀/?)³: 9/5/0

Condition of remains at time of measurement⁴: G/I

Institution holding remains: Maxwell Museum of Anthropology (University of New Mexico),
Albuquerque, NM

Excavator (or donor) and date of excavation: Paul H. Nesbitt (1930s)
Steven A. LeBlanc (1970s and 1980s)

Description of site: These sites were all located along the Mimbres River. All consisted of multiple pueblo room blocks and possibly some pit structures dating to the Classic Mimbres period, constructed over the remains of Late Pithouse period structures. Burials were located in room floors and in burial pits around the pueblos. Most burials contained the typological black-and-white pottery of the Mimbres culture.

References: LeBlanc, 1977; Myers, 1978; LeBlanc and Whalen, 1980; Anyon and LeBlanc, 1984;
Gilman, 1990; Hegemon, 2002

82) Site number¹: LA 162

Site name: Paa-Ko

Location(s): North central New Mexico, east of Albuquerque (35.24, -106.21)

Time period(s): 600 yBP

Region: U.S. Southwest

Cultural affiliation: Pueblo IV (Regressive period)

Subsistence: AGR

Number of individuals observed (♂/♀/?)³: 14/15/0

Condition of remains at time of measurement⁴: G/I

Institution holding remains: San Diego Museum of Man, San Diego, CA

(Paa-Ko, continued)

Excavator (or donor) and date of excavation: Edgar L. Hewett (1935-1937)

Description of site: The site consisted of two pueblos constructed near to the San Pedro Arroyo, a perennial spring. Paa-Ko pueblos were occupied in two periods; primarily, they were constructed and inhabited 600 years ago, then abandoned and reinhabited 400 years ago before being abandoned permanently. All skeletons used in this study date to the concentrated original occupation of the site during the regressive Pueblo IV period. All graves indicate pre-contact artifacts and customs.

References: Lambert and Rogers, 1954

83) Site number¹: LA 416

Site name: Pottery Mound

Location(s): Western central New Mexico, near Los Lunas (34.74, -106.93)

Time period(s): 600 to 500 yBP

Region: U.S. Southwest

Cultural affiliation: Pueblo IV

Subsistence: AGR

Number of individuals observed (♂/♀/?)³: 25/19/0

Condition of remains at time of measurement⁴: VG/NC

Institution holding remains: Maxwell Museum of Anthropology (University of New Mexico), Albuquerque, NM

Excavator (or donor) and date of excavation: Frank C. Hibben (1954-1961)

Description of site: Located along the Rio Puerco, the site consists of a single prominent mound built up over four distinct periods. A single, early structure from Pueblo III likely formed the base of the later construction. The Pueblo IV occupation left a single pueblo of multiple rooms and a prominent kiva. Burials were uncovered primarily in midden areas of the site, with the remainder in the floors of rooms. All skeletons used in this study are associated with Pueblo IV period artifacts.

References: Hibben, 1955; Schorsch, 1962; Brock & Ruff, 1987; Phillips & Ballagh, 2003

84) Site number¹: None assigned

Site name: Pueblo Bonito

Location(s): Northwestern New Mexico in Chaco Canyon (36.06, 107.95)

Time period(s): 1000 to 700 yBP

Region: U.S. Southwest

Cultural affiliation: Pueblo III (Chaco culture)

Subsistence: AGR

Number of individuals observed (♂/♀/?)³: 4/10/0

Condition of remains at time of measurement⁴: VG/NC

Institution holding remains: National Museum of Natural History (Smithsonian), Washington, DC

Excavator (or donor) and date of excavation: Neil Judd (1920-1927)

Description of site: Located in Chaco Canyon, this was one of numerous sites located within a six-mile stretch of the canyon that have been attributed to the (Grand) Chaco culture. The pueblo was a single large complex of hundreds of rooms constructed against a cliff and around two large enclosures. Only those burials located within the pueblo were excavated; no cemetery was identified by Judd.

References: Douglass, 1935; Judd, 1954; Elliot, 1995

85) Site number¹: None assigned

Site name: Puye Cliff Dwellings

Location(s): Northern New Mexico, in Santa Clara Canyon near Espanola (35.93, -106.16)

Time period(s): 700 to 400 yBP

Region: U.S. Southwest

Cultural affiliation: Pueblo IV (Pajaritan?)

Subsistence: AGR

Number of individuals observed (♂/♀/?)³: 17/23/0

Condition of remains at time of measurement⁴: VG/NC

Institution holding remains: National Museum of Natural History (Smithsonian), Washington, DC

Excavator (or donor) and date of excavation: Edgar L. Hewett (1906-1907)

Description of site: A single pueblo constructed into a volcanic rock cliffside, the pueblo consisted of over 700 preserved rooms and multiple stories. Burials were excavated from within the pueblo and in nearby shelters. Regressive Pueblo IV period pottery is associated this pueblo.

References: Hewett, 1907; Seltzer, 1944; Spuhler, 1954; Corruccini, 1972

86) Site number¹: LA 581

Site name: Tijeras

Location(s): In the Tijeras Canyon, east of Albuquerque (35.09, -106.39)

Time period(s): 600 to 300 yBP

Region: U.S. Southwest

Cultural affiliation: Pueblo IV

Subsistence: AGR

Number of individuals observed (♂/♀/?)³: 5/0/0

Condition of remains at time of measurement⁴: VG/NC

Institution holding remains: Maxwell Museum of Anthropology (University of New Mexico), Albuquerque, NM

Excavator (or donor) and date of excavation: Linda S. Cordell (1970s)

Description of site: Located in the Tijeras Canyon, the site consists of a pueblo that was modified in the middle of the site's occupation from a semi-circular structure surrounding a circular kiva to a U-shaped pueblo adjacent to a rectangular kiva. Burials were located in the floors of rooms and adjacent to the pueblo.

References: Myers, 1976, 1978

OHIO

87) Site number¹: None assigned

Site name: Fort Ancient / Oregonia

Location(s): Southeastern Ohio, on the east bank of the Little Miami River (39.42, -84.07)

Time period(s): 1000 to 400 yBP

Region: Prairie and Eastern Woodlands

Cultural affiliation: Fort Ancient

Subsistence: AGR

Number of individuals observed (♂/♀/?)³: 16/8/0

Condition of remains at time of measurement⁴: VG/NC

Institution holding remains: Field Museum of Natural History, Chicago, IL

Excavator (or donor) and date of excavation: Warren K. Moorehead (1891-1892)

(Fort Ancient/Oregonia, continued)

Description of site: The site was located on a farm in southwestern Ohio. Burials were concentrated into a single mound (Taylor's Mound) and a terrace, on which Moorehead also uncovered evidence of a village that he attributed to the Fort Ancient culture, based on artifacts and the nature of ash pits found around the site.

References: Moorehead, n.d.

88) Site number¹: None assigned

Site name: Libben

Location(s): Central northern coastal Ohio, near to Lacarne (41.51, -83.04)

Time period(s): ca. 1150 to 850 yBP

Region: Prairie and Eastern Woodlands

Cultural affiliation: Western Basin Tradition (Libben phase)

Subsistence: IH

Number of individuals observed (♂/♀/?)³: 23/27/2

Condition of remains at time of measurement⁴: G/I

Institution holding remains: Kent State University, Kent, OH

Excavator (or donor) and date of excavation: C. Owen Lovejoy (1967-1968)

Description of site: The site was located on the northern bank of the Portage River, just short of its outflow into Lake Erie. Excavations revealed evidence of a perpetual 200 to 300 year occupation of the site by a people who exhibited little agricultural subsistence. Over 1300 burials, including infants, were excavated, yielding one of the most comprehensively investigated sites in North America.

References: Lovejoy et al., 1977

89) Site number¹: 33HA36

Site name: Madisonville

Location(s): Southeastern Ohio, just south of Madisonville (39.16, -84.38)

Time period(s): ca. 500 to 300 yBP

Region: Prairie and Eastern Woodlands

Cultural affiliation: Late Fort Ancient

Subsistence: AGR

Number of individuals observed (♂/♀/?)³: 18/19/3

Condition of remains at time of measurement⁴: VG/NC

Institution holding remains: Harvard University Peabody Museum of Archaeology and Ethnology, Cambridge, MA

Excavator (or donor) and date of excavation: Frederic W. Putnam (1870s)

Charles Metz (1879-1881, 1890s)

R. E. Merwin (1907-1908)

Description of site: The site, which was bequeathed to Harvard University, is located on a terrace near to the Little Miami River. Excavations revealed an extensive village and burial complex, wherein burials and features—namely cache pits—held both late pre-contact and post-contact artifacts. Burials used in this study most likely dated to the late pre-contact period.

References: Putnam, 1883a; Hooton and Willoughby, 1920; Drooker, 1997

90) Site number¹: None assigned

Site name: Turner Mounds

Location(s): Southeastern Ohio, near to the Anderson Township (38.95, -83.41)

Time period(s): ca. 2000 yBP

(Turner Mounds, continued)

Region: Prairie and Eastern Woodlands

Cultural affiliation: Adena culture (?)

Subsistence: IH

Number of individuals observed (♂/♀/?)³: 4/0/0

Condition of remains at time of measurement⁴: VG/NC

Institution holding remains: Harvard University Peabody Museum of Archaeology and Ethnology, Cambridge, MA

Excavator (or donor) and date of excavation: Charles Metz (1880s)

Description of site: The site was comprised of a group of thirteen mounds—presumably for ceremonial and burial purposes—located along the Little Miami River. Artifacts found with the burials included copper ornaments, and evidence for cremations and possible hearth pits were located among the burials. No habitation was reported in association with the site.

References: Putnam, 1883b; Willoughby and Hooten, 1922

SOUTH DAKOTA

91) Site number¹: 39WW1

Site name: Mobridge

Location(s): North-central South Dakota, near to the city of Mobridge (45.56, -100.46)

Time period(s): 700 to 250 yBP (2 distinct occupations)

Region: Great Plains

Cultural affiliation: Arikara (Plains Village 2)

Subsistence: VHH

Number of individuals observed (♂/♀/?)³: 27/14/0

Condition of remains at time of measurement⁴: VG/NC

Institution holding remains: National Museum of Natural History (Smithsonian), Washington, DC

Excavator (or donor) and date of excavation: William Bass (1968-1970)
Douglas Ubelaker (1971)

Description of site: The site consisted of two hills bordering on an archaeological village located along the eastern floodplain of the upper Missouri River. Burials were uncovered in the hillsides.

References: Owsley et al., 1982; Blakeslee, 1994; Owsley and Jantz, 1994

92) Site number¹: 39WW2

Site name: Larson

Location(s): North-central South Dakota, near to the city of Mobridge (45.46, -100.46)

Time period(s): 200 to 165 yBP

Region: Great Plains

Cultural affiliation: Arikara (Coalescent period)

Subsistence: VHH

Number of individuals observed (♂/♀/?)³: 16/15/1

Condition of remains at time of measurement⁴: VG/NC

Institution holding remains: University of Tennessee – Knoxville, Knoxville, TN

Excavator (or donor) and date of excavation: William Bass (1966-1968)

Description of site: This was an archaeological earth lodge village with an associated cemetery, the site was located on the eastern bank of the Missouri River.

References: Owsley and Bass, 1979; Blakeslee, 1994; Owsley and Jantz, 1994

93) Site number¹: 39ST1

Site name: Cheyenne River

Location(s): Central South Dakota, north of the Cheyenne River at its merger with the Missouri River (44.03, -100.46)

Time period(s): 200 yBP

Region: Great Plains

Cultural affiliation: Arikara (Coalescent period)

Subsistence: VHH

Number of individuals observed (♂/♀/?)³: 15/11/0

Condition of remains at time of measurement⁴: VG/NC

Institution holding remains: National Museum of Natural History (Smithsonian), Washington, DC

Excavator (or donor) and date of excavation: Douglas Ubelaker (1971)

Description of site: This was an archaeological village and cemetery adjacent to the Cheyenne River, partially eroding into the river at the time of the excavation.

References: Blakeslee, 1994; Thiessen, 1999

94) Site number¹: 39SL4

Site name: Sully

Location(s): Central South Dakota (44.60, -100.57)

Time period(s): 200 yBP

Region: Great Plains

Cultural affiliation: Arikara (Coalescent period)

Subsistence: VHH

Number of individuals observed (♂/♀/?)³: 12/8/0

Condition of remains at time of measurement⁴: VG/NC

Institution holding remains: National Museum of Natural History (Smithsonian), Washington, DC

Excavator (or donor) and date of excavation: Robert Stephenson (1956-1957)
William Bass (1960s)

Description of site: This was an archaeological earth lodge village and cemetery located on a plateau alongside the Missouri River, consisting over possibly as many as 400 lodges with associated ceremonial structures.

References: Owsley and Jantz, 1978; Blakeslee, 1994; Owsley and Jantz, 1994

95) Site number¹: 39ST203, 39CA4, 39BF2, 39CH9

Site name: Black Widow Ridge, Anton Rygh, Medicine Crow, Charles Mix

Location(s): Central South Dakota (44.43, -100.46; 45.66, -100.29; 44.03, -99.33; 43.20, -98.50)

Time period(s): 200 yBP

Region: Great Plains

Cultural affiliation: Arikara (Coalescent period)

Subsistence: VHH

Number of individuals observed (♂/♀/?)³: 0/7/0

Condition of remains at time of measurement⁴: VG/NC

Institution holding remains: National Museum of Natural History (Smithsonian), Washington, DC

Excavator (or donor) and date of excavation: William Bass (1960s)

Description of site: These were sites surveyed while the larger sites along the Missouri River were excavated in South Dakota. Most consisted of isolated burials and few archaeological features.

References: Owsley and Jantz, 1978; Blakeslee, 1994

TENNESSEE

96) Site number¹: 40DV60

Site name: Averbuch

Location(s): Central Tennessee, near to Nashville (36.26, 86.85)

Time period(s): 750 to 500 yBP

Region: Southeastern United States

Cultural affiliation: Late Mississippian (Middle Cumberland)

Subsistence: AGR

Number of individuals observed (♂/♀/?)³: 24/27/5

Condition of remains at time of measurement⁴: VG/NC

Institution holding remains: University of Tennessee – Knoxville, Knoxville, TN

Excavator (or donor) and date of excavation: William Bass & Walter Klippel (1975-1978)

Description of site: Located among tributaries to the Cumberland River, the Averbuch site consisted of multiple cemeteries surrounding a briefly (no more than 100 years) occupied village. This village was also surrounded by a palisade wall. Over 600 burials, many of which were stone box graves, were excavated from the site.

References: Guagliardo, 1980; Berryman, 1981; Klippel and Reed, 1984; Muendel, 1997; Hamilton, 1999

97) Site number¹: 40BY14

Site name: Candy Creek

Location(s): Southeastern Tennessee, at the confluence of Candy Creek and the Tennessee River (35.33, -84.85)

Time period(s): Late Woodland (Candy Creek phase)

Region: Southeastern United States

Cultural affiliation: 1000 to 600 yBP

Subsistence: IH

Number of individuals observed (♂/♀/?)³: 1/1/0

Condition of remains at time of measurement⁴: G/I

Institution holding remains: Frank H. McClung Museum, University of Tennessee, Knoxville, TN

Excavator (or donor) and date of excavation: George A. Lidberg (1939)

Description of site: The site was on the western bank of the Hiwassee River, adjacent to Ledford Island (where inhabitants had some interaction with each other). Two burial concentrations were identified, though the only signs of habitation were disorganized post molds and a shallow basin.

References: Lidberg et al., 1995a

98) Site number¹: 40BN74

Site name: Cherry

Location(s): Western central Tennessee, near to Halls (36.14, -88.19)

Time period(s): 4000 to 3000 yBP

Region: Southeastern United States

Cultural affiliation: Late Archaic (Big Sandy)

Subsistence: FHG

Number of individuals observed (♂/♀/?)³: 15/5/0

Condition of remains at time of measurement⁴: VG/NC

Institution holding remains: Frank H. McClung Museum, University of Tennessee, Knoxville, TN

Excavator (or donor) and date of excavation: Douglas Osborne (1941)

(Cherry, continued)

Description of site: Located between the Big Sandy and the Tennessee Rivers, in the ridges along the Big Sandy River, this site was geographically and temporally close to the Eva site.

Temporally, the site consisted of only one occupation represented by a series of pits and middens. The majority of the reported excavation consisted of a cemetery.

References: Osborne, 1941; Smith, 2006

99) Site number¹: 40GN6

Site name: Ebenezer

Location(s): Northeastern Tennessee, in the town of Chuckey (36.23, -82.65)

Time period(s): 3000 to 2500 yBP

Region: Southeastern United States

Cultural affiliation: Early Woodland

Subsistence: FHG

Number of individuals observed (♂/♀/?)³: 8/3/0

Condition of remains at time of measurement⁴: G/I

Institution holding remains: Frank H. McClung Museum, University of Tennessee, Knoxville, TN

Excavator (or donor) and date of excavation: L.W. McIlhany (1967)

Description of site: The site was a looted site located near to a church (Ebenezer) in Chuckey, Tennessee, along the Nolichucky River. Associated burial lithics were used to identify the temporal period of the burials. No evidence of habitations were reported with the burials.

References: Site report forms

100) Site number¹: 40BN12

Site name: Eva

Location(s): Western central Tennessee, now inundated by Kentucky Lake (36.06, -88.00)

Time period(s): 7200 to 5000 yBP

Region: Southeastern United States

Cultural affiliation: Middle Archaic (Eva, Benton, and Big Sandy phases)

Subsistence: FHG

Number of individuals observed (♂/♀/?)³: 19/13/0

Condition of remains at time of measurement⁴: VG/NC

Institution holding remains: Frank H. McClung Museum, University of Tennessee, Knoxville, TN

Excavator (or donor) and date of excavation: Douglas Osborn (1940)

Description of site: The site was located on a grassy levee that once was situated along a set of stream channels, and consisted of five strata within a shell mound. No evidence of permanent structures was reported, though the site was occupied for a long time period. The majority of the skeletons (72%) included in this study are associated with the Benton/Three Mile cultural phase.

References: Lewis and Lewis, 1961; Herrmann, 2002

101) Site number¹: 40MG31, (Units: 38, 42, VT-1)

Site name: Hiwassee

Location(s): Southeastern Tennessee, at the confluence of the Hiwassee and Tennessee Rivers, near to the city of Dayton (35.43, -85.00)

Time period(s): 600 to 200 yBP

Region: Southeastern United States

Cultural affiliation: Middle Mississippian (Dallas phase)

Subsistence: AGR

Number of individuals observed (♂/♀/?)³: 20/17/3

(Hiwassee, continued)

Condition of remains at time of measurement⁴: VG/NC

Institution holding remains: Frank H. McClung Museum, University of Tennessee, Knoxville, TN

Excavator (or donor) and date of excavation: Clarence B. Moore (1915)

Mark R. Harrington (1919)

Charles H. Nash & Wendell C. Walker (1937-1939)

Charles Fairbanks (1938-1939)

Description of site: The Hiwassee site is located on an island at the confluence of the Hiwassee and Tennessee Rivers, and demonstrates multiple occupations from at least the Woodland period until after European contact. Four distinct cultural groups were identified as archaeological occupants, constructing villages, ceremonial and burial mounds on the island. The majority of the skeletons (all except 4) utilized in this study are associated with the Dallas phase Mississippian culture, which supplanted the Hamilton culture previously occupying the island. Four skeletons have tentatively been associated with the Hamilton culture.

References: Lewis and Kneberg, 1970

102) Site number¹: 40BN25

Site name: Ledbetter Landing

Location(s): Western central Tennessee, near the confluence Morgan Creek and the Tennessee River
(35.97, -88.03)

Time period(s): 4000 to 3000 yBP

Region: Southeastern United States

Cultural affiliation: Late Archaic

Subsistence: FHG

Number of individuals observed (♂/♀/?)³: 13/4/0

Condition of remains at time of measurement⁴: G/I

Institution holding remains: Frank H. McClung Museum, University of Tennessee, Knoxville, TN

Excavator (or donor) and date of excavation: George A. Lidberg (1940)

Description of site: The site was located along the Tennessee River on a natural levee in the river's floodplain. Only a cemetery was excavated; Lidberg hypothesized that the habitation had been washed away by the river. Two occupation periods were represented by the site: the skeletons used in this study were associated with a Late Archaic occupation (associated with Big Sandy); remaining skeletons from a shallower stratum were associated by pottery to the Early Woodland period.

References: Lidberg, 1941; Higgins, 1982; Smith, 2006

103) Site number¹: 40BY13

Site name: Ledford Island

Location(s): Southeastern Tennessee, at the confluence of Candy Creek and the Tennessee River
(35.33, -84.85)

Time period(s): 500 to 300 yBP

Region: Southeastern United States

Cultural affiliation: Late Mississippian (Mouse Creek phase)

Subsistence: AGR

Number of individuals observed (♂/♀/?)³: 19/21/1

Condition of remains at time of measurement⁴: G/I

Institution holding remains: Frank H. McClung Museum, University of Tennessee, Knoxville, TN

Excavator (or donor) and date of excavation: George A. Lidberg (1938-1939)

(Ledford Island, continued)

Description of site: A riverine island located in the Hiwasee River at its confluence with the Candy and Rogers Creeks, much of the site was disturbed by plowing and flooding. Midden and shallow pits, along with hearths indicated the presence of a number of dwellings, as well as a communal house constructed of logs. A stockade may have also been present. Burials were located throughout the site (both within and outside of dwellings), with some pits reused for multiple burial events. Although Dallas phase Mississippian and Late Woodland Candy Creek artifacts were located at the site, almost all archaeological evidence supports a primary Mouse Creek cultural occupation of the island.

References: Boyd and Boyd, 1991; Lidberg et al., 1995b

104) Site number¹: 40RE8

Site name: Montgomery

Location(s): Central eastern Tennessee, east of the city of Rockwood (35.86, -84.56)

Time period(s): 1000 to 600 yBP

Region: Southeastern United States

Cultural affiliation: Late Woodland (Candy Creek phase)

Subsistence: IH

Number of individuals observed (♂/♀/?)³: 2/0/0

Condition of remains at time of measurement⁴:

Institution holding remains: Frank H. McClung Museum, University of Tennessee, Knoxville, TN

Excavator (or donor) and date of excavation: Carroll A. Burroughs (1940)

Description of site: Like many other sites that were the result of archaeological surveys, the Montgomery site consisted only of burials alongside the Tennessee River without any reported associated habitation.

References: Burroughs and Nash, site report

105) Site number¹: 40SM4

Site name: Robinson

Location(s): North central Tennessee, near to Carthage and the Cordell Hull Reservoir (36.28, -85.94)

Time period(s): 3000 to 2500 yBP

Region: Southeastern United States

Cultural affiliation: Late Archaic

Subsistence: FHG

Number of individuals observed (♂/♀/?)³: 4/2/0

Condition of remains at time of measurement⁴: G/I

Institution holding remains: Frank H. McClung Museum, University of Tennessee, Knoxville, TN

Excavator (or donor) and date of excavation: Dan F. Morse (1963)

Description of site: The site consisted of a shell mound along an archaeological stream bed, with three possible occupation periods. Signs of habitation were mostly from middens and post molds Morse interpreted as indicative of a communal house. Most of the skeletons from the site are associated with Late Archaic lithic material.

References: Morse and Polhemus III, site report

106) Site number¹: 40HY5

Site name: Thompson Village

Location(s): Northwestern central Tennessee, on the lower Tennessee River (36.41, -88.03)

Time period(s): 900 to 500 yBP

Region: Southeastern United States

(Thompson Village, continued)

Cultural affiliation: Middle Mississippian

Subsistence: AGR

Number of individuals observed (♂/♀/?):³: 12/11/3

Condition of remains at time of measurement⁴: G/I

Institution holding remains: Frank H. McClung Museum, University of Tennessee, Knoxville, TN

Excavator (or donor) and date of excavation: George A. Lidberg (1939)

Description of site: Near to the confluence of the Big Sandy and Tennessee Rivers, just south of the Big Sandy River, this site was located on a floodplain on the west bank of the Tennessee River. Two occupations were identified from the Late Woodland and the Middle Mississippian periods, though only the latter yielded preserved evidence of dwellings. All skeletons used in this study were associated with the Middle Mississippian occupation's two burial concentrations; burials from the Woodland occupation were poorly preserved.

References: Lidberg, 1940

107) Site number¹: 40MR6

Site name: Toqua

Location(s): Southeastern Tennessee, along the Little Tennessee River near to Howard (35.57, -84.18)

Time period(s): 600 to 300 yBP

Region: Southeastern United States

Cultural affiliation: Late Mississippian (Dallas phase)

Subsistence: AGR

Number of individuals observed (♂/♀/?):³: 17/18/2

Condition of remains at time of measurement⁴: VG/NC

Institution holding remains: Frank H. McClung Museum, University of Tennessee, Knoxville, TN

Excavator (or donor) and date of excavation: Richard Polehemus & Gerald Schroedl (1975-1978)

Description of site: The site was located on the south bank of the Little Tennessee River on a natural terrace. Two mounds and a large distribution of middens provided evidence of an extensive occupation of the site, as well as shallow pits that indicated the presence of dwelling structures. Burials were placed into the floors of dwellings and in the mounds located at the site, and numbered over 400 skeletons. All skeletons used in this study were associated with the Late Mississippian Dallas phase.

References: Polehemus, 1987

108) Site number¹: 40RE6

Site name: Wilson

Location(s): Central eastern Tennessee, east of the city of Rockwood (35.86, -84.56)

Time period(s): 1500 to 1000 yBP

Region: Southeastern United States

Cultural affiliation: Middle Woodland

Subsistence: IH

Number of individuals observed (♂/♀/?):³: 2/0/0

Condition of remains at time of measurement⁴: G/I

Institution holding remains: Frank H. McClung Museum, University of Tennessee, Knoxville, TN

Excavator (or donor) and date of excavation: Carroll A. Burroughs (1940-1941)

Description of site: The site was located on a bluff overlooking the Tennessee River floodplain, consisting of a shell mound with interred burials deposited in three phases. No habitation is reported in association with the site.

References: Burroughs, site report

TEXAS

109) Site number¹: 41GV1

Site name: Caplen

Location(s): Southeastern coastal Texas, on the Bolivar Peninsula (29.50, -94.52)

Time period(s): 1000 to 400 yBP

Region: South Texas

Cultural affiliation: Akokisa (?)

Subsistence: MHG

Number of individuals observed (♂/♀/?)³: 7/7/1

Condition of remains at time of measurement⁴: P/F

Institution holding remains: Texas Archaeological Research Laboratory (University of Texas – Austin), Austin, Texas

Excavator (or donor) and date of excavation: J. E. Pearce (1930s)
A. M. Woolsey (1932)

Description of site: The site was located on a peninsula on the eastern side of Galveston Bay. A general lack of artifactual finds outside of funerary objects was reported for the site, and Campbell hypothesized that the habitation associated with the site was located elsewhere. Over 60 burials were uncovered, many with pottery that indicated a Late Prehistoric occupation, and one with post-contact glass beads, indicating at least one Historic burial. All skeletons used in this study were from the Late Prehistoric phase of the site's occupation.

References: Campbell, 1957

110) Site number¹: 41AU36

Site name: Ernest Whitte

Location(s): Southeastern Texas, near the Brazos River and the town Wallis (29.63, -96.06)

Time period(s): 2500 to 1600 yBP

Region: South Texas

Cultural affiliation: Middle Archaic

Subsistence: BSHG

Number of individuals observed (♂/♀/?)³: 7/4/1

Condition of remains at time of measurement⁴: VP

Institution holding remains: Texas Archaeological Research Laboratory (University of Texas – Austin), Austin, Texas

Excavator (or donor) and date of excavation: Grant D. Hall (1970s)

Description of site: A large cemetery located between the Brazos River and Allens Creek on a bluff, the site demonstrated four distinct occupations by what were most likely culturally distinct groups. The earliest skeletons dated to 4600 yBP, and the most recent to the early Historic period. Most of the skeletons used in this study were associated with the Middle Archaic period; two skeletons may be associated with the Early Archaic, though these were highly fragmentary.

References: Hall, 1981; Taylor, 2001

111) Site number¹: 41VV74

Site name: Fate Bell Shelter

Location(s): Central southern Texas, within Seminole Canyon (29.70, -101.37)

Time period(s): ca. 2000 yBP

Region: South Texas

Cultural affiliation: Late Archaic

Subsistence: BSHG

Number of individuals observed (♂/♀/?)³: 2/3/1

(Fate Bell Shelter, continued)

Condition of remains at time of measurement⁴: P/F

Institution holding remains: Texas Archaeological Research Laboratory (University of Texas – Austin), Austin, Texas

Excavator (or donor) and date of excavation: A.T. Jackson (1932)

Description of site: A series of at least eight rock shelters within the Seminole Canyon were excavated, most showing evidence of long-term human occupation, including mortar holes and pictographs. Burials were discovered in various locations within the largest shelter, designated “Site 1” by Jackson. Numerous lithic points, sandals, and remains of baskets and textiles were also recovered from the shelters. No absolute dates were made on material from the site, so its temporal association is uncertain.

References: Jackson, 1933; Pearce and Jackson, 1933

112) Site number¹: None assigned

Site name: Horn Shelter

Location(s): Central Texas, near to the city of Waco (31.49, -97.13)

Time period(s): ca. 10000 to 9500 yBP

Region: Great Plains

Cultural affiliation: Early Holocene pre-Archaic (“Paleoindian”)

Subsistence: BSHG

Number of individuals observed (♂/♀/?)³: 1/0/0

Condition of remains at time of measurement⁴: G/I

Institution holding remains: Private ownership

Excavator (or donor) and date of excavation: Frank Watt and Al Redder (1970)

Description of site: Located on the western bank of the Brazos River, the site consisted of a limestone rock shelter with many strata, indicating multiple occupations of the site. Most notable were the presence of hearths, a fragmentary Folsom point in a deeper stratum than the burials, and numerous faunal remains. Two burials have been associated with this site: a juvenile and an adult, the latter of which is included in this study. The juvenile may have been added after the initial burial of the adult male. Associated with the burials were shell ornaments and a turtle carapace, which had been placed over the face of the male.

References: Young et al., 1987; Baker, 1998; Powell, 2005

113) Site number¹: 41WM230

Site name: Loeve Fox

Location(s): Central Texas, near to the town of Circleville (30.64, -97.39)

Time period(s): ca. 1500 to 1000 yBP

Region: Great Plains

Cultural affiliation: Late Archaic (Austin focus, terminal phase)

Subsistence: BSHG

Number of individuals observed (♂/♀/?)³: 12/6/1

Condition of remains at time of measurement⁴: G/I

Institution holding remains: Texas Archaeological Research Laboratory (University of Texas – Austin), Austin, Texas

Excavator (or donor) and date of excavation: Walton R. Prewitt (1972-1973)

Description of site: The site was located on a wooded terrace on the western bank of the San Gabriel River, along the remains of at least two extinct streams. Some of the site had been previously disturbed, but hearths and a large area of distributed lithics and debris were uncovered in addition to a small cemetery. Prewitt hypothesized one burial indicated social stratification.

References: Prewitt, 1974

114) Site number¹: 41MD1

Site name: Scharbauer Site (“Midland Woman”)

Location(s): Western central Texas, near to the city of Midland (32.02, -102.06)

Time period(s): 11,000 to 10,000 yBP

Region: Great Plains

Cultural affiliation: Early Holocene pre-Archaic (“Paleoindian”)

Subsistence: BSHG

Number of individuals observed (♂/♀/?)³: 0/1/0

Condition of remains at time of measurement⁴: VP

Institution holding remains: Private ownership

Excavator (or donor) and date of excavation: Fred Wendorf (1953-1954)

Description of site: Located in a sand dune blow-out on the border of a ranch, the site consisted of a calvarium, teeth, fragmentary facial bones, and associated lithics. Despite repeated excavations at the same location, no other remains were discovered.

References: Internal report, Texas Archaeological Survey; Powell, 2005

115) Site number¹: 41GV66

Site name: Mitchell Ridge

Location(s): Southeast coastal Texas, located on Galveston Island (29.25, -94.91)

Time period(s): ca. 500 yBP

Region: South Texas

Cultural affiliation: Karankawa (Late Prehistoric)

Subsistence: MHG

Number of individuals observed (♂/♀/?)³: 11/9/0

Condition of remains at time of measurement⁴: G/I

Institution holding remains: Texas Archaeological Research Laboratory (University of Texas – Austin), Austin, Texas

Excavator (or donor) and date of excavation: Barbara B. Atkins (1974-1978)
Robert A. Racklis (1992)

Description of site: The site was located on a wooded ridge on Galveston Island, showed little stratigraphy, and has been interpreted to represent a intermittent habitation, occupied during the period just before and after European contact. No evidence of dwelling structures has been reported in connection with the site, though middens were excavated. Burials were congregated into a single cemetery site surrounded by layers of shell.

References: Atkins, n.d.; Racklis, 1994

116) Site number¹: 41WM235

Site name: Wilson-Leonard

Location(s): Eastern central Texas, between the Spanish Oak and Brushy Creeks (30.57, -97.64)

Time period(s): 10,000 to 9500 yBP

Region: Great Plains

Cultural affiliation: Early Holocene pre-Archaic (“Paleoindian”)

Subsistence: BSHG

Number of individuals observed (♂/♀/?)³: 0/1/0

Condition of remains at time of measurement⁴: P/F

Institution holding remains: Texas Archaeological Research Laboratory (University of Texas – Austin), Austin, Texas

Excavator (or donor) and date of excavation: Davis, Miller, and Stiba (1983)

(Wilson-Leonard, continued)

Description of site: A rockshelter located alongside two creeks, the site had been the location of a late Pleistocene pond that had become filled shortly before the burial of this skeleton. At least one, and possibly two other individuals' remains were uncovered at the site, though Wilson-Leonard II was the most intact. Unique lithics were uncovered above the level of the burial, though gravels in the burial pit indicated that these stone points and the burial were likely from the same time period.

References: Internal report, Texas Archaeological Survey; Collins, 1998; Steele, 1998; Powell, 2005

UTAH

117) Site number¹: None assigned

Site name: Fort Douglas

Location(s): Salt Lake City, on the Fort Douglas campus (40.78, -111.90)

Time period(s): 4000 to 3000 yBP

Region: Great Basin

Cultural affiliation: Archaic

Subsistence: BSHG

Number of individuals observed (♂/♀/?)³: 1/0/0

Condition of remains at time of measurement⁴: G/I

Institution holding remains: Utah Museum of Natural History (Univ. of Utah), Salt Lake City, UT

Excavator (or donor) and date of excavation: Unknown

Description of site: An isolated skeleton retrieved during construction at Fort Douglas, this was found near the campus of the University of Utah. Little additional information is available about this site or this individual skeleton.

References: Internal report, Utah Museum of Natural History

118) Site number¹: 42TO64

Site name: Black Rock

Location(s): Northwestern Utah, on the Great Salt Lake's southern shore (40.68, -112.32)

Time period(s): 1500 to 1000 yBP

Region: Great Basin

Cultural affiliation: Fremont (Great Salt Lake)

Subsistence: IH

Number of individuals observed (♂/♀/?)³: 2/0/0

Condition of remains at time of measurement⁴: P/F

Institution holding remains: Utah Museum of Natural History (Univ. of Utah), Salt Lake City, UT

Excavator (or donor) and date of excavation: Julian Steward (1931)

David B. Madsen (1980)

Description of site: A single wave-cut cave located on the southern periphery of the Great Salt Lake, the site served multiple occupancies likely dating to the early Holocene. Based on associated lithics, the two burials recovered from the site are dated from the Fremont period.

References: Madsen, 1983

119) Site number¹: 42UN95

Site name: Caldwell Village

Location(s): Northeastern Utah, near the town of Lapoint (40.41, -109.82)

Time period(s): 900 to 750 yBP

Region: Great Basin

(Caldwell Village, continued)

Cultural affiliation: Fremont

Subsistence: IH

Number of individuals observed (♂/♀/?)³: 2/4/1

Condition of remains at time of measurement⁴: VG/NC

Institution holding remains: Utah Museum of Natural History (Univ. of Utah), Salt Lake City, UT

Excavator (or donor) and date of excavation: Richard Ambler (1964)

Description of site: A single habitation site that consisted of more than 20 pit houses, the site exhibited signs of irrigated agriculture, and human and dog burials located in storage pits dug within the pit houses, as well as isolated burials. As the site had been disturbed from modern agriculture, inferences about the entire site were difficult and conjectural.

References: Ambler, 1966

120) Site number¹: 42GA34

Site name: Coombs

Location(s): Central southern Utah, near Boulder (37.91, -111.43)

Time period(s): 800 to 700 yBP

Region: Southwest U.S.

Cultural affiliation: Ancient Pueblo (“Anasazi”)

Subsistence: AGR

Number of individuals observed (♂/♀/?)³: 1/1/0

Condition of remains at time of measurement⁴: G/I

Institution holding remains: Utah Museum of Natural History (Univ. of Utah), Salt Lake City, UT

Excavator (or donor) and date of excavation: Robert H. Lister (1958-1959)

Description of site: The site consisted of a series of related structures (more than 20), including some that may have been constructed long after the abandonment of the site by the Ancient Pueblo inhabitants. Burials were interspersed throughout the site, mostly outside of habitation structures.

References: Lister et al., 1960

121) Site number¹: 42SL1

Site name: Deadman’s Cave

Location(s): North central Utah, southeast of Salt Lake City on the southern shore of the Great Salt Lake (40.77, -112.11)

Time period(s): 5000 to 3000 yBP

Region: Great Basin

Cultural affiliation: Archaic

Subsistence: BSHG

Number of individuals observed (♂/♀/?)³: 1/0/0

Condition of remains at time of measurement⁴: P/F

Institution holding remains: Utah Museum of Natural History (Univ. of Utah), Salt Lake City, UT

Excavator (or donor) and date of excavation: Elmer Smith (1938-1941)

Description of site: A wave-cut cave located on the southern coast of the Great Salt Lake, the site contained the heavily disturbed remains of at least four individuals. Associations with specific artifacts were not made in the site report, though the artifacts were generally identified as “prepuebloan.”

References: Buettner-Janush, 1954

122) Site number¹: 42SA8540

Site name: Duna Leyenda

Location(s): Southeastern Utah (37.27, -109.56)

Time period(s): 1500 to 1200 yBP

Region: Southwest U.S.

Cultural affiliation: Basketmaker III

Subsistence: AGR

Number of individuals observed (♂/♀/?)³: 4/2/0

Condition of remains at time of measurement⁴: G/I

Institution holding remains: Utah Museum of Natural History (Univ. of Utah), Salt Lake City, UT

Excavator (or donor) and date of excavation: Unknown

Description of site: No site report is available for these skeletons, though the association with Basketmaker III is secure.

References: Owsley et al., n.d.

123) Site number¹: 42IN40/42IN124/42IN43

Site name: Evans Site/Median Village/Parogonah Mounds

Location(s): Southwestern Utah, near to the city of Parowan (37.80, -112.94)

Time period(s): 1000 to 600 yBP

Region: Great Basin

Cultural affiliation: Fremont (Parowan)

Subsistence: IH

Number of individuals observed (♂/♀/?)³: 3/4/0

Condition of remains at time of measurement⁴: G/I

Institution holding remains: Utah Museum of Natural History (Univ. of Utah), Salt Lake City, UT

Excavator (or donor) and date of excavation: Neil M. Judd (1917-1920s)

Clement W. Meighan (1954-1960)

David B. Madsen (1960s)

Description of site: All three sites were located in close geographic proximity in the Parowan Valley. All were agricultural sites that apparently formed a trade center. The Evans site consisted of a single mound holding multiple pit house dwellings and isolated burials. The Median Village was a single village on a slope, also consisting of multiple pit houses and isolated burials. Parogonah Mounds had been disturbed by previous excavations and looting, and so little remained when the site was systematically excavated by Meighan beginning in 1954; records and site reconstructions indicate multiple mounds and dwellings, again with isolated burials.

References: Anderson, 1956; Marwitt, 1973; Dodd, 1982

124) Site number¹: 42EM3 and 42EM4

Site name: Ferron Creek

Location(s): Central Utah, along the Ferron Creek (39.00, -111.25)

Time period(s): 900 to 750 yBP

Region: Great Basin

Cultural affiliation: Fremont

Subsistence: IH

Number of individuals observed (♂/♀/?)³: 2/1/0

Condition of remains at time of measurement⁴: P/F

Institution holding remains: Utah Museum of Natural History (Univ. of Utah), Salt Lake City, UT

Excavator (or donor) and date of excavation: James H. Gunnerson (1954-1956)

(Ferron Creek, continued)

Description of site: Both sites were located on gravelly ridges/knolls alongside the Ferron Creek, and both consisted of small habitation sites with pit houses and some evidence of irrigation networks. Burials were found as a result of a survey, and therefore likely represent a larger cemetery population in the region.

References: Gunnerson, 1957

125) Site number¹: Various, including 42SA544, 42SA735, 42SA738, 42SA2140

Site name: Glen Canyon sites

Location(s): Southeastern Utah, in the Glen Canyon region (37.28, -110.85)

Time period(s): 800 to 660 yBP

Region: Southwest U.S.

Cultural affiliation: Ancient Pueblo (“Anasazi”)

Subsistence: AGR

Number of individuals observed (♂/♀/?)³: 33/23/4

Condition of remains at time of measurement⁴: G/I

Institution holding remains: Utah Museum of Natural History (Univ. of Utah), Salt Lake City, UT
National Museum of Natural History (Smithsonian), Washington, DC
American Museum of Natural History, New York, NY

Excavator (or donor) and date of excavation: Neil Judd (1910s)

Description of site: These are various skeletons found in the lower Glen Canyon region. Little provenance information was available from the accession records of the Utah Museum of Natural History; site data may be on file with the Utah Historical Society. Skeletons from the Smithsonian Institution were from Alkali Ridge.

References: Internal reports, UMNH and NMNH

126) Site number¹: 42WB34

Site name: Injun Creek

Location(s): Northwest Utah, on the Great Salt Lake’s eastern shore (41.26, -112.16)

Time period(s): 600 to 350 yBP

Region: Great Basin

Cultural affiliation: Fremont (Great Salt Lake)

Subsistence: IH

Number of individuals observed (♂/♀/?)³: 3/1/0

Condition of remains at time of measurement⁴: P/F

Institution holding remains: Utah Museum of Natural History (Univ. of Utah), Salt Lake City, UT

Excavator (or donor) and date of excavation: Melvin Aikens (1960s)

Description of site: A series of thirteen mounds located along the Injun Creek near to Ogden, these demonstrated consistent occupation of the area, including the identified remains of four structures. Burials were found mostly in mounds not associated with structures, though some were located on the flat floodplain.

References: Aikens, 1966

127) Site number¹: 42GR3576

Site name: Polley-Secrest Site

Location(s): Central eastern Utah in the town of Moab (38.57, -109.55)

Time period(s): ca. 1000 yBP

Region: Great Basin

Cultural affiliation: Fremont

Subsistence: IH

(Polley-Secret Site)

Number of individuals observed (♂/♀/?)³: 6/1/1

Condition of remains at time of measurement⁴: G/I

Institution holding remains: U.S. Department of the Interior, Bureau of Land Management

Excavator (or donor) and date of excavation: Lloyd Pierson (1959, 1976)

Description of site: This small cemetery was located on the site of a house and was encountered accidentally. No extensive excavation of the area was possible, and the skeletons were salvaged from the site. No grave artifacts were reported with the skeletons with the exception of two burials.

References: Kopp, 2006

WASHINGTON

128) Site number¹: 45BN52

Site name: Kennewick

Location(s): Central southern Washington (46.20, -119.16)

Time period(s): ca. 9400 yBP

Region: Western Plateau

Cultural affiliation: Early Holocene pre-Archaic (“Paleoindian”)

Subsistence: BSHG

Number of individuals observed (♂/♀/?)³: 1/0/0

Condition of remains at time of measurement⁴: E/C

Institution holding remains: Burke Museum of Natural History and Culture, Seattle, WA
(under the control of the Army Corps of Engineers)

Excavator (or donor) and date of excavation: Floyd Johnson and James Chatters (1996)

Description of site: Located along the riverbank of the Columbia River, the skeleton that came to be identified as Kennewick Man was discovered eroding from the river bank. Disturbance and artifact temporal contamination of the site has made its reconstruction difficult, though the skeleton was found with a point imbedded in its right iliac blade.

References: Chatters et al., 1999; Chatters, 2000; Powell, 2005; Owsley, n.d.

Canada sites

BRITISH COLUMBIA

129) Site number¹: GbTo-36

Site name: Baldwin

Location(s): Northwestern British Columbia, in Prince Rupert Harbor (54.28, -130.35)

Time period(s): ca. 3000 to 2000 yBP

Region: Pacific Northwest

Cultural affiliation: Period II Tshimshian

Subsistence: MHG

Number of individuals observed (♂/♀/?)³: 5/1/0

Condition of remains at time of measurement⁴: VG/NC

Institution holding remains: Canadian Museum of Civilization, Gatineau, QC

Excavator (or donor) and date of excavation: George MacDonald, Richard Inglis, Joyce May,
& Bjorn Simonsen (1966-1987)

(Baldwin, continued)

Description of site: Located on the western shore of Kaien Island, on the eastern side of the Prince Rupert Harbor, this small site consisted of a shell midden and over two dozen burials. The midden was located just south of the Lachane site, and overlapped temporally with it. Two burials were radiocarbon dated to ca. 2900 yBP and ca. 2200 yBP, placing this site close to but not at the terminal occupation of the harbor by the Tshimshian.

References: Cybulski, 1975; Cybulski, 1978; MacDonald and Cybulski, 2001

130) Site number¹: GbTo-31

Site name: Boardwalk

Location(s): Northwestern British Columbia, in Prince Rupert Harbor (54.29, -130.28)

Time period(s): 3500 to 1500 yBP

Region: Pacific Northwest

Cultural affiliation: Period II Tshimshian

Subsistence: MHG

Number of individuals observed (♂/♀/?)³: 20/9/0

Condition of remains at time of measurement⁴: G/I

Institution holding remains: Canadian Museum of Civilization, Gatineau, QC

Excavator (or donor) and date of excavation: George MacDonald, Richard Inglis,
Joyce May, & Bjorn Simonsen (1966-1987)

Description of site: An extensive midden deposit and associated house depressions, this site was located on the far eastern shore of Digby Island, near to Dodge Cove and along the western side of Prince Rupert Harbor. A large number of houses and over 100 burials were recovered from this site, many likely dating to the end of the Tshimshian occupation of the Prince Rupert Harbor before they were forced out by the neighboring Tlingit. A high incidence of interpersonal violence is inferred from a number of cranial and forearm fractures at this site.

References: Cybulski, 1975; Cybulski, 1978; Cybulski, 1999; MacDonald & Cybulski, 2001

131) Site number¹: GbTo-18

Site name: Dodge Island

Location(s): Northwestern British Columbia, in Prince Rupert Harbor (54.30, -130.28)

Time period(s): 3500 to 2500 yBP (?)

Region: Pacific Northwest

Cultural affiliation: Late Period I Tshimshian (?)

Subsistence: MHG

Number of individuals observed (♂/♀/?)³: 4/2/0

Condition of remains at time of measurement⁴: G/I

Institution holding remains: Canadian Museum of Civilization, Gatineau, QC

Excavator (or donor) and date of excavation: George MacDonald, Richard Inglis,
Joyce May, & Bjorn Simonsen (1966-1987)

Description of site: A small island located near to Dodge Cove in western Prince Rupert Harbor, this site consisted of a midden with eroding burials. One burial was dated to ca. 2800 yBP, though, stratigraphically, some burials were earlier and later than this one. No associated habitations were reported in association with the burials.

References: Cybulski, 1975; Cybulski, 1978; MacDonald and Cybulski, 2001

132) Site number¹: None assigned

Site name: Fort Rupert

Location(s): Southwestern British Columbia, on Vancouver Island (50.70, -127.43)

Time period(s): ca. 100 yBP

(Fort Rupert, continued)

Region: Pacific Northwest

Cultural affiliation: Kwakiutl

Subsistence: MHG

Number of individuals observed ($\text{♂}/\text{♀}/\text{?}$): 8/5/1

Condition of remains at time of measurement⁴: G/I

Institution holding remains: American Museum of Natural History, New York, NY

Excavator (or donor) and date of excavation: Harlan I. Smith (Jesup North Pacific Expedition)
(1897-1899)

Description of site: A shell mound located on the northwestern edge of Vancouver Island, near to Fort Rupert, this site was originally considered to be of some antiquity by Smith, but yielded few skeletal remains. The burials Smith did acquire were from stone box and tree burials, which were undoubtedly post-contact. Cybulski's analysis of crania from this site indicated close affiliation with known proto- and post-contact Kwakiutl.

References: Smith, 1899a; Boas, 1903; Cybulski, 1975; Fitzhugh and Krupnik, 2006

133) Site number¹: GbTo-23

Site name: Garden Island

Location(s): Northwestern British Columbia, in Prince Rupert Harbor (54.31, -130.39)

Time period(s): 2000 to 1600 yBP

Region: Pacific Northwest

Cultural affiliation: Period II Tshimshian (?)

Subsistence: MHG

Number of individuals observed ($\text{♂}/\text{♀}/\text{?}$): 4/4/1

Condition of remains at time of measurement⁴: G/I

Institution holding remains: Canadian Museum of Civilization, Gatineau, QC

Excavator (or donor) and date of excavation: George MacDonald, Richard Inglis,
Joyce May, & Bjorn Simonsen (1966-1987)

Description of site: Located on Garden Island, a small projection in the northwestern Prince Rupert Harbor, like Dodge Island, this site consisted of a midden with eroding burials. Few burials had associated burial artifacts (or artifact associations were uncertain due to midden erosion), and preservation was generally poor.

References: Cybulski, 1975; Cybulski, 1978; MacDonald and Cybulski, 2001

134) Site number¹: None assigned

Site name: (Port) Hammond

Location(s): Southwestern British Columbia, near to Vancouver (49.23, -122.68)

Time period(s): ca. 500 to 100 YBP (?)

Region: Pacific Northwest

Cultural affiliation: Coast Salish (?)

Subsistence: MHG

Number of individuals observed ($\text{♂}/\text{♀}/\text{?}$): 4/2/0

Condition of remains at time of measurement⁴: G/I

Institution holding remains: American Museum of Natural History

Excavator (or donor) and date of excavation: Harlan I. Smith (Jesup North Pacific Expedition)
(1897-1899)

(Hammond, continued)

Description of site: The site was located somewhat inland from the Port Hammond area, along the Fraser River. Smith described this site as a shell mound with deposited burials that he suggested belonged to two groups. It is possible that this site represented two occupations—one by the Kwakiutl and one by the Coast Salish—or one occupation with cultural transition in cranial deformation practices. Stratigraphy at the site was not well-documented, though Smith did report multiple strata. The site is pre-contact, based on artifacts found in the midden, but its antiquity has not been determined. Generally poor preservation in British Columbia of remains of deep antiquity, and the generally good preservation of these skeletons may indicate a fairly recent temporal affiliation.

References: Smith, 1899a; Boas, 1903; Fitzhugh and Krupnik, 2006

135) Site number¹: None assigned

Site name: Kamloops

Location(s): Central southern British Columbia, near Kamloops (50.63, -120.34) and Nicola Lake (50.17, -120.50)

Time period(s): ca. 900 to 500 yBP

Region: Western Plateau

Cultural affiliation: pre-Coastal Salish (?)

Subsistence: FHG

Number of individuals observed (♂/♀/?)³: 6/3/1

Condition of remains at time of measurement⁴: E/C

Institution holding remains: American Museum of Natural History, New York, NY

Excavator (or donor) and date of excavation: Harlan I. Smith (Jesup North Pacific Expedition) (1897-1899)

Description of site: Smith uncovered these burials from exposed rock slides located along the Thompson River. Most of the burials contained large lithic points that are unlike those made by the Coast Salish. Smith reported that the Salish disclaimed affiliation with this lithic technology, indicating that either these burials pre-date modern Salish occupation of the region. A Douglas fir stump in one mound indicated that the site was at least 500 years old.

References: Smith, 1899a, 1899b, 1900; Boas, 1903; Fitzhugh and Krupnik, 2006

136) Site number¹: GbTo-33

Site name: Lachane (Reservior)

Location(s): Northwestern British Columbia, in Prince Rupert Harbor (54.28, -130.35)

Time period(s): 2500 to 1500 yBP

Region: Pacific Northwest

Cultural affiliation: Period II Tshimshian

Subsistence: MHG

Number of individuals observed (♂/♀/?)³: 10/2/0

Condition of remains at time of measurement⁴: VG/NC

Institution holding remains: Canadian Museum of Civilization, Gatineau, QC

Excavator (or donor) and date of excavation: George MacDonald, Richard Inglis, Joyce May, & Bjorn Simonsen (1966-1987)

Description of site: A shell midden located on the western coast of Kaien Island, along the eastern side of Prince Rupert Harbor, this site consisted of a group of pit houses and over 70 burials. Like Boardwalk (GbTo-31), this site was likely part of the terminal Tshimshian occupation of the Prince Rupert Harbor region, and also presents evidence of interpersonal violence and/or head trophy acquisition (at least one decapitated individual was found).

References: Cybulski, 1975; Cybulski, 1978; Cybulski, 1996; MacDonald & Cybulski, 2001

137) Site number¹: None assigned

Site name: Lillooet Valley

Location(s): Western south-central British Columbia, near Lytton (50.22, -121.57), and Lillooet (50.67, -121.93)

Time period(s): ca. 400 to 200 yBP (?)

Region: Western Plateau

Cultural affiliation: Coast Salish (?)

Subsistence: FHG

Number of individuals observed (♂/♀/?)³: 3/2/0

Condition of remains at time of measurement⁴: VG/NC

Institution holding remains: American Museum of Natural History, New York, NY

Excavator (or donor) and date of excavation: Harlan I. Smith (Jesup North Pacific Expedition) (1897-1899)

Description of site: These burials were located in eroded rock slides along the Fraser River. Smith reported that some post-contact artifacts were uncovered among the burial artifacts. Whether these were intrusive was not mentioned, though their presence suggests that these burials were very recent. Smith did consider these burials to be associated with the Salish or closely-related tribes.

References: Smith, 1899a, 1899b, 1900; Boas, 1903; Fitzhugh and Krupnik, 2006

138) Site number¹: None assigned

Site name: Nanaimo

Location(s): Southwestern British Columbia, on Vancouver Island (49.17, -124.00)

Time period(s): ca. 200 to 100 yBP

Region: Pacific Northwest

Cultural affiliation: Nootka (?)

Subsistence: MHG

Number of individuals observed (♂/♀/?)³: 8/3/0

Condition of remains at time of measurement⁴: E/C

Institution holding remains: American Museum of Natural History, New York, NY

Excavator (or donor) and date of excavation: Harlan I. Smith (Jesup North Pacific Expedition) (1897-1899)

Description of site: Although this sample comes from sites proximate to the modern city of Nanaimo on the northern coast of southwestern Vancouver Island—an area occupied by the Coast Salish—the shape of the crania is similar to that described ethnographically for the Nootka (Nuu-chah-nulth). Little is recorded about these skeletons, so provenience information is tentative.

References: Boas, 1903; Cybulski, 1999; Fitzhugh and Krupnik, 2006

139) Site number¹: None assigned

Site name: Nimpkish

Location(s): Southwestern British Columbia, on Vancouver Island (50.50, -127.00)

Time period(s): ca. 100 yBP

Region: Pacific Northwest

Cultural affiliation: Kwakiutl

Subsistence: MHG

Number of individuals observed (♂/♀/?)³: 6/4/0

Condition of remains at time of measurement⁴: G/I

Institution holding remains: American Museum of Natural History, New York, NY

Excavator (or donor) and date of excavation: Harlan I. Smith (Jesup North Pacific Expedition) (1897-1899)

(Nimpkish, continued)

Description of site: Nimpkish was located on the northern coast of northwestern Vancouver Island. Like the skeletons from Fort Rupert, these burials were located in stone box and tree burials near to Nimpkish, rather than from the older shell mounds he also investigated in the area.

References: Smith, 1899a; Boas, 1903; Cybulski, 1975; Fitzhugh and Krupnik, 2006

140) Site number¹: None assigned

Site name: North Sannich

Location(s): Southwestern British Columbia, on Vancouver Island (48.63, -123.45)

Time period(s): ca. 100 yBP

Region: Pacific Northwest

Cultural affiliation: Coast Salish

Subsistence: MHG

Number of individuals observed (♂/♀/?)³: 9/5/0

Condition of remains at time of measurement⁴: VG/NC

Institution holding remains: American Museum of Natural History, New York, NY

Excavator (or donor) and date of excavation: Harlan I. Smith (Jesup North Pacific Expedition)
(1897-1899)

Description of site: The site was located on the northern coast of southwestern Vancouver Island, north of Victoria. Smith excavated shell mounds and cairns, the latter which provided the skeletons used in this study.

References: Fitzhugh and Krupnik, 2006

MANITOBA

141) Site number¹: Mounds: Mound B, Mound R, Mound 4, Mound 6

Site name: Antler Plain / Souris River Mounds

Location(s): Southwestern Manitoba, along the Antler & Souris Rivers (49.14, -101.03)

Time period(s): 1000 to 500 yBP

Region: Great Plains

Cultural affiliation: Late Woodland (Melita Phase?)

Subsistence: VHH

Number of individuals observed (♂/♀/?)³: 9/3/3

Condition of remains at time of measurement⁴: G/I

Institution holding remains: Canadian Museum of Civilization, Gatineau, QC

Excavator (or donor) and date of excavation: H. Montgomery (1907-1910)
William Sims (1908)
W.B. Nickerson (1912-1915)

Description of site: These sites consisted of complexes of mounds along the floodplain of the North and South Antler Rivers, their confluence with the Souris River, and the floodplain between these confluences. Mound chronology is somewhat uncertain due to the number of investigators and the lack of professional excavation by some in southern Manitoba, though artifacts and comparative analyses place all sites within the Late Woodland of southern Canada. Mounds have mixed uses, and few burials were found among them; those burials uncovered were often isolated, some were secondary, and habitation structures were seldom reported in conjunction with them.

References: Capes, 1963; Syms, 1978

142) Site number¹: IeKn-1, IeKn-4, IeKn-5

Site name: Fort Prince of Wales

Location(s): Northeastern Manitoba, near to Fort Prince of Wales (58.78, -94.17)

Time period(s): ca. 100 yBP

Region: Central Arctic

Cultural affiliation: Inuit (MacKenzie?)

Subsistence: MHG

Number of individuals observed (♂/♀/?)³: 1/2/0

Condition of remains at time of measurement⁴: G/I

Institution holding remains: Canadian Museum of Civilization, Gatineau, QC

Excavator (or donor) and date of excavation: Charles F. Merbs (1964)

Description of site: These three burials were isolated internments in rock cairns along the western coast of the Hudson Bay in northeastern Manitoba. Merbs' evaluation of the graves and the artifacts led him to conclude that all three burials had been from the post-contact period.

References: Merbs, internal notes at the Canadian Museum of Civilization

143) Site number¹: Mounds: Sims Mound (113), Star Mound (115)

Site name: Snowflake

Location(s): Central southern Manitoba, along the Pembina River: Sims Mounds (49.07, -98.67), Star Mounds (49.06, -98.78)

Time period(s): 1300 to 1000 yBP

Region: Great Plains

Cultural affiliation: Middle Woodland (Manitoba Phase?)

Subsistence: VHH

Number of individuals observed (♂/♀/?)³: 5/2/1

Condition of remains at time of measurement⁴: P/F

Institution holding remains: Canadian Museum of Civilization, Gatineau, QC

Excavator (or donor) and date of excavation: William Sims (1908)

W.B. Nickerson (1912-1915)

Description of site: Located by tributaries of the Pembina River in the river floodplain, these sites represent a mixed-function group of mounds. No associated habitation sites were described, though burial artifacts and radiocarbon dates for Sims Mound securely associate these mounds with the late Middle Woodland.

References: Capes, 1963; Syms, 1978

144) Site number¹: Mound 157

Site name: Stott Mound

Location(s): Central Manitoba, in the central Assiniboine River valley (49.62, -100.26)

Time period(s): 1000 to 600 yBP

Region: Great Plains

Cultural affiliation: Late Woodland (Blackduck Phase?)

Subsistence: VHH

Number of individuals observed (♂/♀/?)³: 2/0/0

Condition of remains at time of measurement⁴: E/C

Institution holding remains: Canadian Museum of Civilization, Gatineau, QC

Excavator (or donor) and date of excavation: R. MacNeish (1954)

Description of site: Located on the middle Assiniboine River floodplain, near to its confluence with the Minnedosa River, the site consisted of an isolated mound. Artifacts uncovered in the mound indicated an early Late Woodland affiliation, possibly with the Blackduck cultural phase from further north in Manitoba.

References: Syms, 1978

NUNAVUT & NORTHWESTERN TERRITORIES

145) Site number¹: LeHv-1, KlJe-1, KkJg-1

Site name: Chesterfield Inlet

Location(s): Western Hudson Bay, around the Chesterfield Inlet: Inuksivik (63.95, 89.5),
Kamarvik (64.95, -89.48), Kiklewait & Silumiut Island (63.44, -90.96)

Time period(s): ca. 800 to 300 yBP

Region: Central Arctic

Cultural affiliation: Thule culture (Inuit)

Subsistence: MHG

Number of individuals observed (♂/♀/?)³: 13/7/1

Condition of remains at time of measurement⁴: VG/NC

Institution holding remains: Canadian Museum of Civilization, Gatineau, QC

Excavator (or donor) and date of excavation: Charles F. Merbs (1967-1969)

Description of site: These sites were clustered around the Chesterfield Inlet in the Hudson Bay.

Their association with the Sadlermiut is uncertain, though ethnographic evidence suggests that the latter were isolated from geographically-proximate groups. Large cemeteries were located at these sites, especially Silumiut Island, wherein most individuals were buried in stone box graves above ground. Artifacts discovered in the graves represent Thule culture without any evidence of trade items with Europeans or other cultural groups; these skeletons were from the pre-contact period.

References: Merbs, n.d.

146) Site number¹: None assigned

Site name: MacKenzie District

Location(s): Northern Nunavut Territory and Northwest Territory: Great Bear Lake (65.21, -123.41),
Baillie Island (70.57, -128.18), Young Point (56.35, -78.39), Rondrock Lake
(64.37, -113.50), Fort Simpson (61.86, -121.34)

Time period(s): ca. 200 to 100 yBP

Region: Central Arctic

Cultural affiliation: Inuit (MacKenzie)

Subsistence: MHG

Number of individuals observed (♂/♀/?)³: 2/6/1

Condition of remains at time of measurement⁴: G/I

Institution holding remains: Canadian Museum of Civilization, Gatineau, QC

Excavator (or donor) and date of excavation: D. Jenness, F. Johannsen (1916)

Description of site: These skeletons were collected from isolated Inuit burials encountered by the Stephanson Arctic Expedition (1900s and 1910s). Documentation for these skeletons is poor, though they likely are associated with recent inhabitants of the extreme north.

References: Internal documentation at the Canadian Museum of Civilization

147) Site number¹: Kh?

Site name: Sadlermiut

Location(s): Native Point, on the southern coast of Southampton Island (64.14, -83.27)

Time period(s): 300 to 100 yBP (?)

Region: Central Arctic

Cultural affiliation: Sadlermiut Inuit

Subsistence: MHG

Number of individuals observed (♂/♀/?)³: 26/27/4

Condition of remains at time of measurement⁴: E/C

Institution holding remains: Canadian Museum of Civilization, Gatineau, QC

(Sadlermiut, continued)

Excavator (or donor) and date of excavation: H.B. Collins (1954)

Charles F. Merbs & William Laughlin (1959)

Description of site: Excavated in two seasons, the site at Native Point represented an extensive cemetery associated with the habitation of the Sadlermiut. Ethnographically, the Sadlermiut, following a population decline in the 19th century, were decimated by a disease outbreak (possibly smallpox) in 1902. Cultural materials from the site demonstrated links with both Thule and Dorest cultures, though these did not affiliate them directly to either culture. Burials were placed in stone box graves and in shallow pits; many had lichen growth due to exposure.

References: Merbs, 1974; Merbs, 1983; Gardiner, 2004

ONTARIO

148) Site number¹: BdHi-1

Site name: Donaldson

Location(s): Southwestern Ontario, on the north bank of the Saugeen River near its convergence with Lake Huron (44.39, -81.27)

Time period(s): ca. 2700 to 2000 yBP

Region: Prairie and Eastern Woodlands

Cultural affiliation: Saugeen (Middle Woodland)

Subsistence: FHG

Number of individuals observed (♂/♀/?)³: 5/3/0

Condition of remains at time of measurement⁴: VG/NC

Institution holding remains: Canadian Museum of Civilization, Gatineau, QC

Excavator (or donor) and date of excavation: T.E. Lee (1950)

J.V. Wright (1960)

Description of site: The site, located on the floodplain of the Saugeen River, was comprised of a few pit house structures, middens, and five “burials,” some of which consisted of numerous individuals. Artifacts found in association with the burials and in the midden placed the site in the Middle Woodland period.

References: Wright and Anderson, 1963

149) Site number¹: 11H1

Site name: Clark Site, Point Pelee

Location(s): Southwestern Ontario, on Point Pelee along Lake Erie (41.98, -82.52)

Time period(s): ca. 1200 to 900 yBP

Region: Prairie and Eastern Woodlands

Cultural affiliation: Middle Woodland

Subsistence: FHG

Number of individuals observed (♂/♀/?)³: 0/3/0

Condition of remains at time of measurement⁴: G/I

Institution holding remains: Canadian Museum of Civilization, Gatineau, QC

Excavator (or donor) and date of excavation: N. Emerson, K. Dawson & J. Wright (1952)

Description of site: Located on a peninsula jutting out of the northern shore of Lake Erie, Point Pelee is a long-term occupation site that served as a regular seasonal habitation location. The skeletons observed for this study were the result of a salvage excavation, and so their temporal provenience is somewhat uncontrolled.

References: Keenlyside, 1978

Guatemala sites

150) Site number¹: None assigned

Site name: Altar de Sacrificios

Location(s): Southwestern Peten province (north central Guatemala), at the confluence of the Rio Salinas and the Rio Pasión (16.47, -90.52)

Time period(s): 1200 to 1000 yBP

Region: Yucatán

Cultural affiliation: Maya (Boca and Jimba phases)

Subsistence: AGR

Number of individuals observed (♂/♀/?)³: 10/5/0

Condition of remains at time of measurement⁴: P/F

Institution holding remains: Harvard University Peabody Museum of Archaeology and Ethnology, Cambridge, MA

Excavator (or donor) and date of excavation: A. Ledyard Smith (1959-1964)

Description of site: The site consists of a large ceremonial complex located in the floodplain between the Rio Salinas and the Rio Pasión. Occupation of the site extended from the Middle Classic Period (ca. 2800 yBP) to the Early Postclassic Period (ca. 800 yBP). The burials used on this study came from two locations: Structure A-I, and Mound 2. Structure A-I was a terraced platform built in multiple stages over time, and Mound 2 likely served as a earthen rise for the support of houses. The skeletons date to the Boca and Jimba phases, ca. 1200 yBP and 1000 yBP, respectively, based on grave artifacts and construction strata.

References: Smith, 1972

Ecuador sites

151) Site number¹: None assigned

Site name: Punta Anllulla: Hacienda Ayalán

Location(s): Southern central western Ecuador, along the Estero Salado (-2.57, -80.18)

Time period(s): 2500 to 1000 yBP

Region: Ecuador

Cultural affiliation: Late Inegration Period (Milagro phase)

Subsistence: AGR

Number of individuals observed (♂/♀/?)³: 6/7/0

Condition of remains at time of measurement⁴: G/I

Institution holding remains: National Museum of Natural History (Smithsonian), Washington, DC

Excavator (or donor) and date of excavation: Earl H. Lubensky (1972)
Douglas H. Ubelaker (1973)

Description of site: The site was located between the towns of Playas and Gómez Rendón, in wooded rise between two estuaries. Urn burials were discovered by Lubensky, who then invited Ubelaker to excavate the cemetery. The majority of internments were in burial urns, though some extended burials were also found; urn burials were, by nature, secondary. Burial at the Ayalán cemetery had an extensive history, though the majority of radiocarbon dates range between 800 and 1300 yBP. The sample for osteometric study from this site is limited, due to the commingling and breakage associated with secondary burial, as well as the acidic soil conditions.

References: Ubelaker, 1981

Peru sites

152) Site number¹: None assigned

Site name: Ancón

Location(s): North central Peruvian western coast, in the town of Ancón (-11.79, -77.18)

Time period(s): 1300 to 700 yBP

Region: Perú

Cultural affiliation: Huari Empire (?)

Subsistence: AGR

Number of individuals observed (♂/♀/?)³: 27/21/3

Condition of remains at time of measurement⁴: VG/NC

Institution holding remains: Field Museum of Natural History, Chicago, IL

Excavator (or donor) and date of excavation: George A. Dorsey (1891-1892)

Description of site: The necropolis at Ancón was a multicomponent site with an extensive burial complex. Many of these burials contained mummified individuals with associated burial artifacts, though the reassociation of these funerary objects and graves has not been fully determined. Initially, the site appeared to originate from the Inca and Chimú cultures. More recent excavations have indicated a long time depth for the site. Artifacts associated with the skeletons at the Field Museum most likely place these burials during the time of the Huari (Wari), though there are likely some individuals associated with later cultures.

References: Dorsey, 1894, 1895; Menzel, 1977; Konigsberg et al., 1993

153) Site number¹: None assigned

Site name: Aramburú

Location(s): In central western Peru, just outside of Lima in Maranga (-12.08, -77.10)

Time period(s): ca. 1700 yBP

Region: Perú

Cultural affiliation: Proto-Lima period

Subsistence: AGR

Number of individuals observed (♂/♀/?)³: 5/5/0

Condition of remains at time of measurement⁴: P/F

Institution holding remains: Field Museum of Natural History, Chicago, IL

Excavator (or donor) and date of excavation: Alfred L. Kroeber (1925)

Description of site: Kroeber described the site as a series of mounds, many of which were constructed with platforms and pyramidal shapes. The mounds were attributed to a “Proto-Lima” time period. One mound held over a dozen burials, many of which were at least partially mummified and bound to litters or other similar constructions.

References: Kroeber, 1954

154) Site number¹: None assigned

Site name: Agua Santa, Cahuachi, Contayo Cax, Majoro Chico, Oncongalla, Soisongo

Location(s): Southwestern Peru, in the Nasca Valley by the Nasca & Tierra Blancas Rivers:

Agua Santa (-14.84, -74.99); Cahuachi (-14.84, -74.97); Contayo Cax (-14.84, -74.895); Majoro Chico (-14.84, -74.985); Oncongalla (-14.84, -74.99); Soisongo (-14.82, -75.05)

Time period(s): 2000 to 1200 yBP

Region: Perú

Cultural affiliation: Nasca culture (all phases)

Subsistence: AGR

Number of individuals observed (♂/♀/?)³: 14/11/0

Condition of remains at time of measurement⁴: P/F

(Nasca sites, continued)

Institution holding remains: Field Museum of Natural History, Chicago, IL

Excavator (or donor) and date of excavation: Alfred L. Kroeber (1926)

Description of site: These sites cluster around the floodplain and drainage of the Rio Tierra Blancas and the Rio Nasca in southwestern Peru's Nasca Valley, within sight of Andean foothills.

Kroeber excavated the sites in large blocks, occasionally exposing multiple internments in one "grave." Ceramics among the sites ranged in period from the earliest Nasca to the terminal phase of the culture before Huari takeover, as well as Hauri ceramics. The majority of skeletons date to the Late Nasca period, though some are from before and after that period. The skeletons used in this study are from the Nasca cultural period.

References: Kroeber and Collier, 1998

155) Site number¹: None assigned

Site name: Cerro Azul

Location(s): Central western coast of Peru, in Cerro Azul (-12.97, -76.48)

Time period(s): ca. 600 to 500 yBP

Region: Perú

Cultural affiliation: Late Cañete (identical to Late Chinchic culture)

Subsistence: AGR

Number of individuals observed (♂/♀/?)³: 2/2/1

Condition of remains at time of measurement⁴: P/F

Institution holding remains: Field Museum of Natural History, Chicago, IL

Excavator (or donor) and date of excavation: Alfred L. Kroeber (1925-1926)

Description of site: Located just inland of the port of Cerro Azul, this site was described by Kroeber as an "imposing cluster of pyramidal ruins" located in a desert plain. Two sets of burials were located on the site: a Late period cemetery constructed within a walled area, and a set of tombs in wall niches (or within walls) from the Middle period. The skeletons from the Late period cemetery associated with these ruins were described by Kroeber and match the sample employed in this study.

References: Kroeber, 1937

156) Site number³: None assigned

Site name: Cerro del Oro

Location(s): Western central Peru, near Cerro Azul (-13.03, -76.44)

Time period(s): ca. 200 to 600 yBP (?)

Region: Perú

Cultural affiliation: Middle Cañete

Subsistence: AGR

Number of individuals observed (♂/♀/?)³: 5/3/1

Condition of remains at time of measurement⁴: G/I

Institution holding remains: Field Museum of Natural History, Chicago, IL

Excavator (or donor) and date of excavation: Alfred L. Kroeber (1925-1926)

Description of site: A single hill located in the foothills just outside of Cerro Azul, this site served as a long-term burial mound that had been disturbed by looters (and likely gave rise to its name). Later buriers appear to have looted earlier graves for construction materials. Middle Cañete period burials were the best-preserved at the site, and so were the focus of Kroeber's excavations.

References: Kroeber, 1937; Holg, 2000

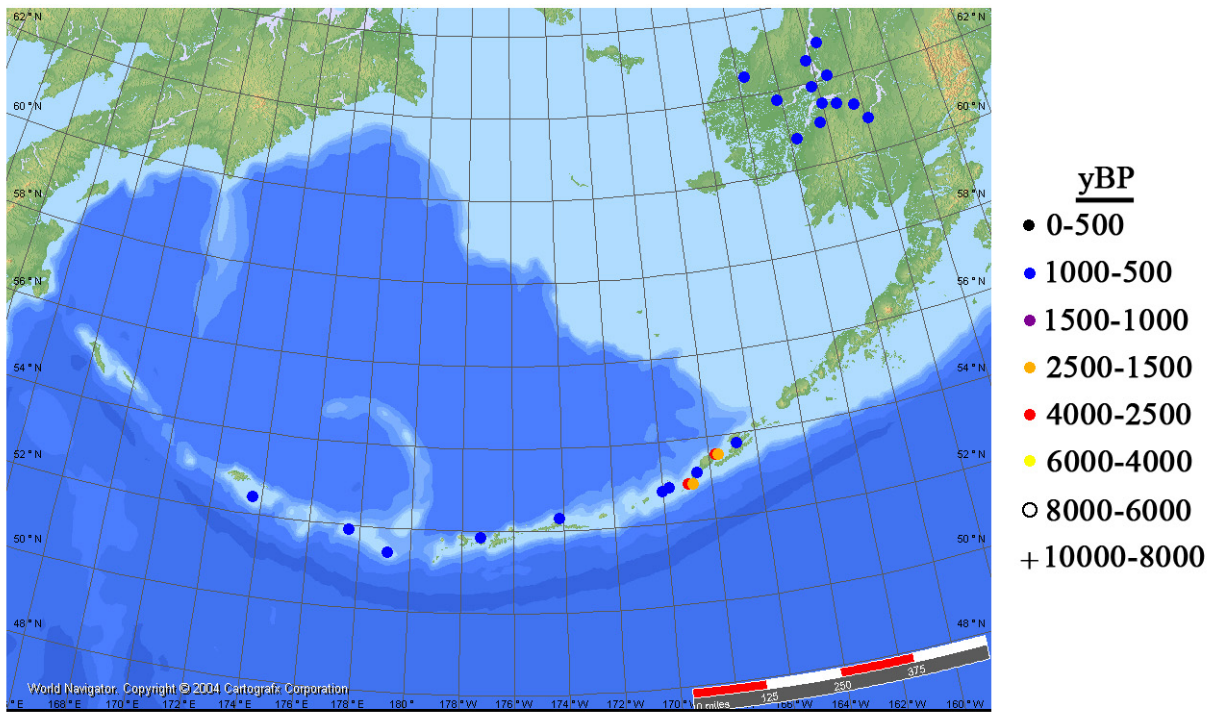


Figure A1.1 Aleutian Islands and southwestern Alaska

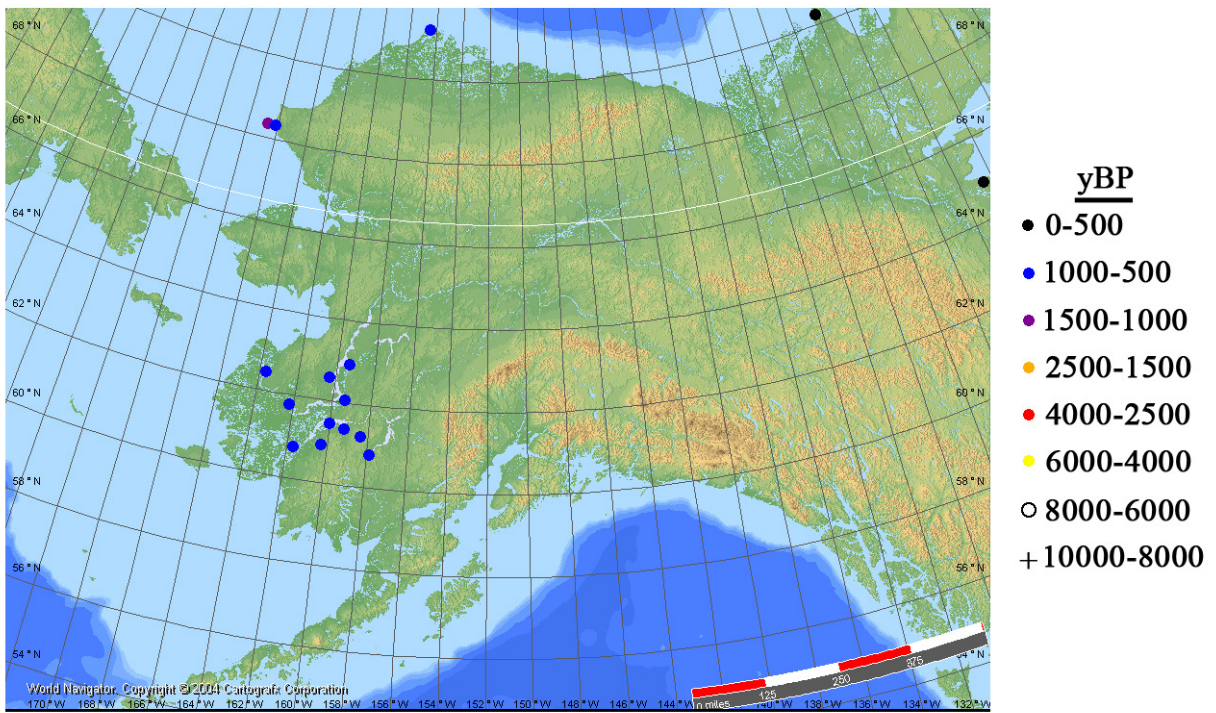


Figure A1.2 Alaska and Yukon

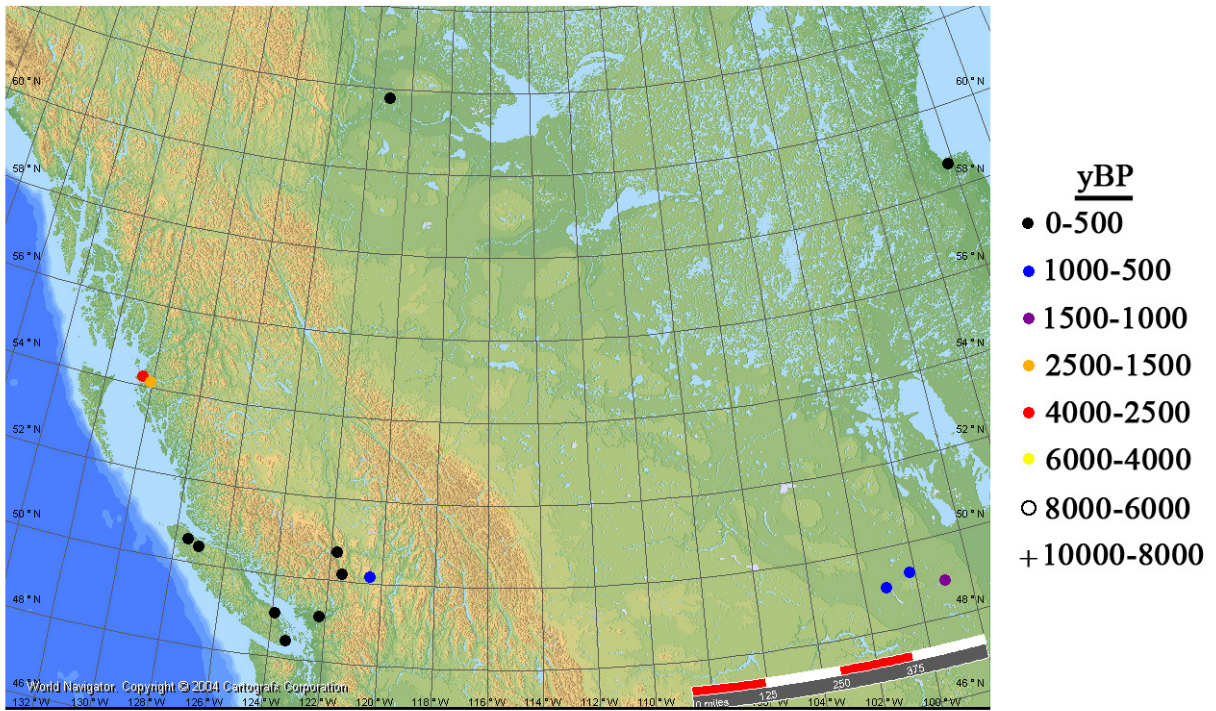


Figure A1.3 Northwestern and north central North America

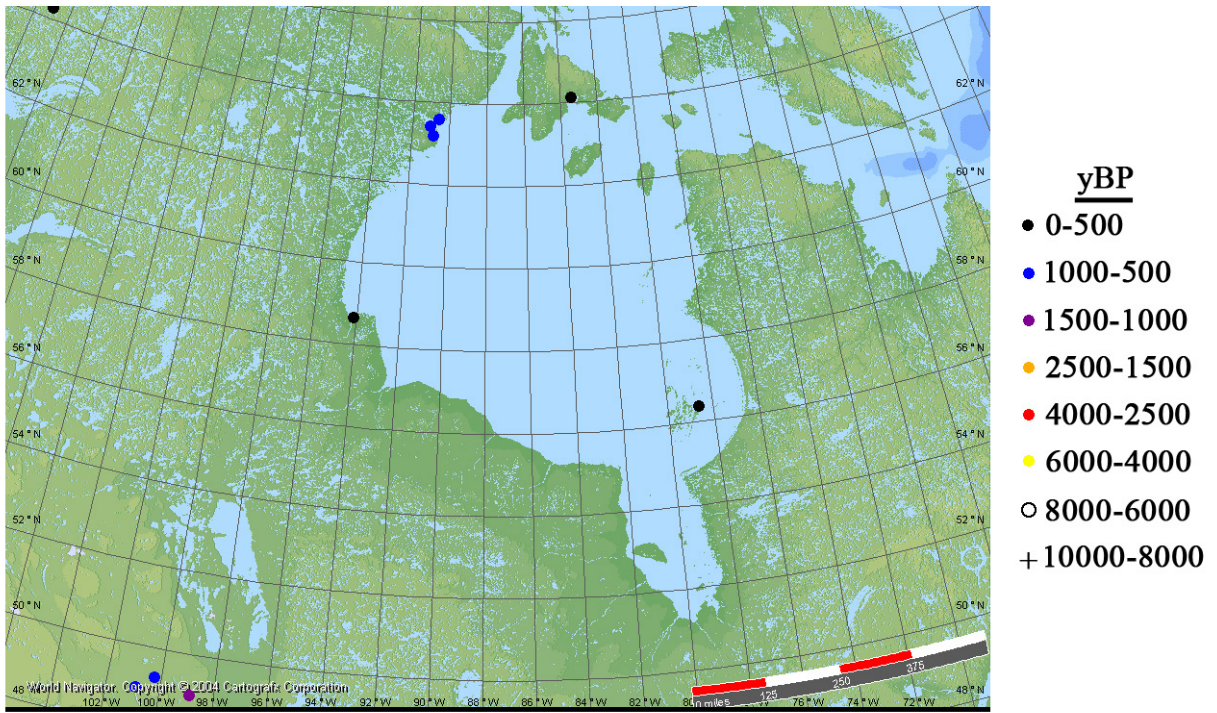


Figure A1.4 Hudson Bay region

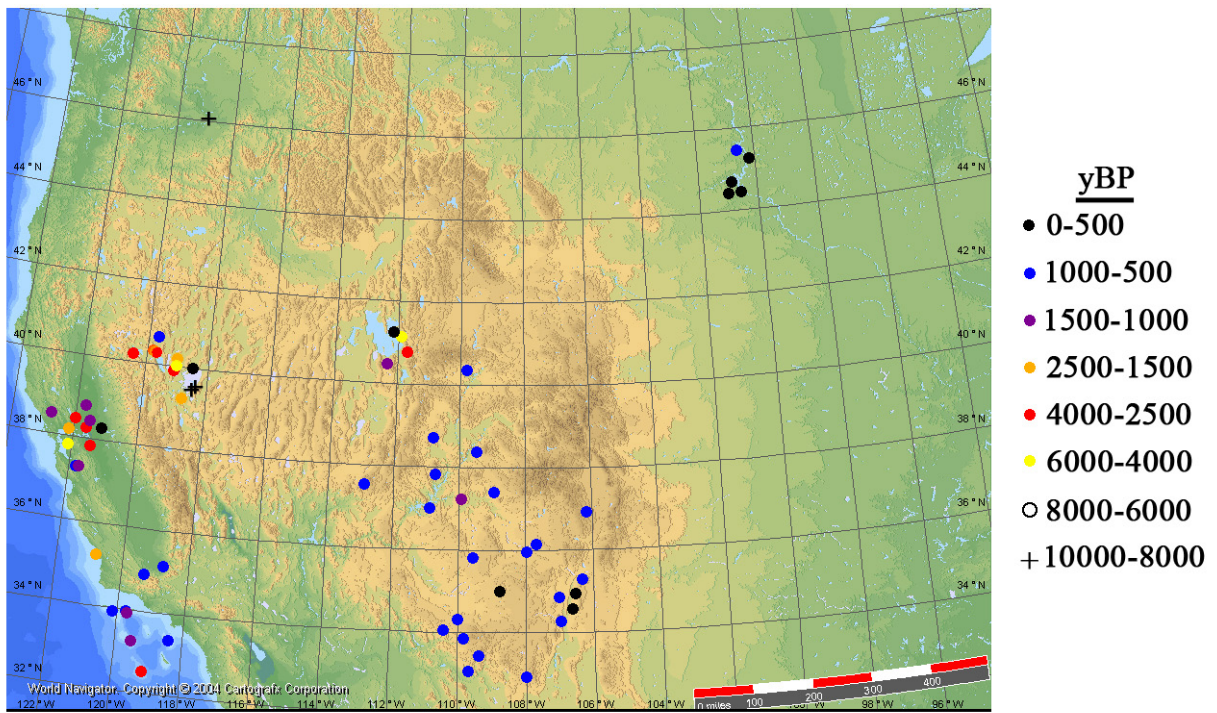


Figure A1.5 Central western North America

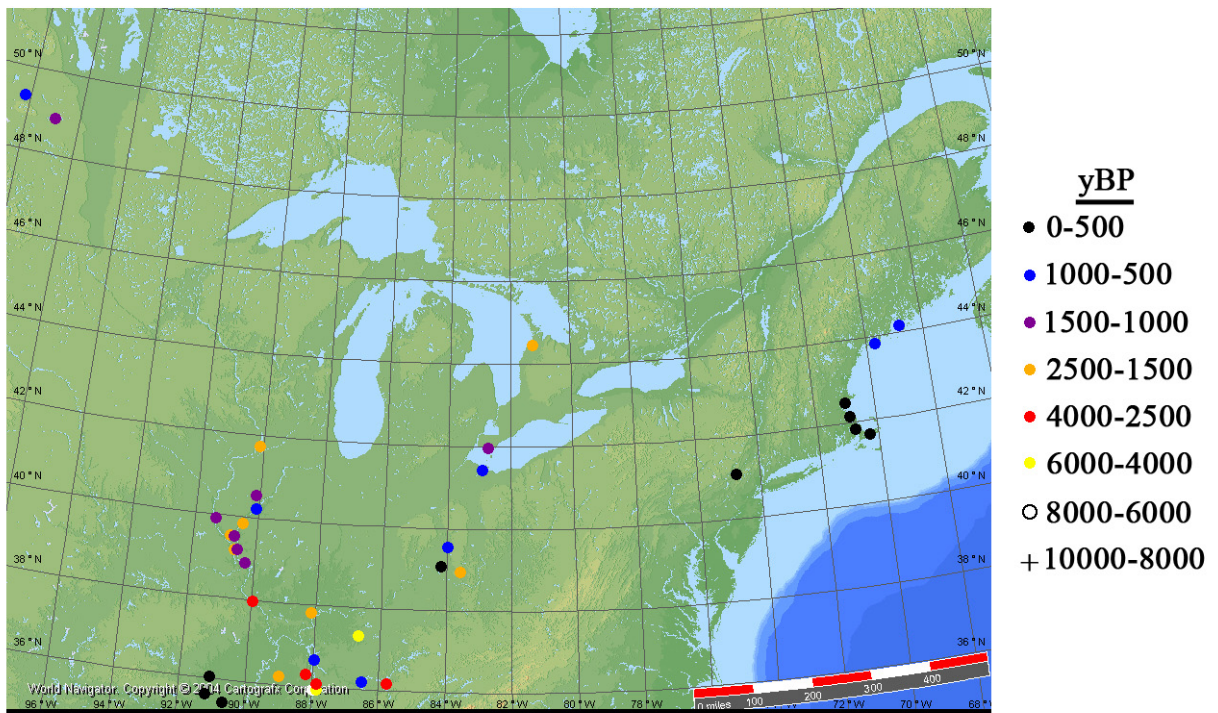


Figure A1.6 Northeastern central North America

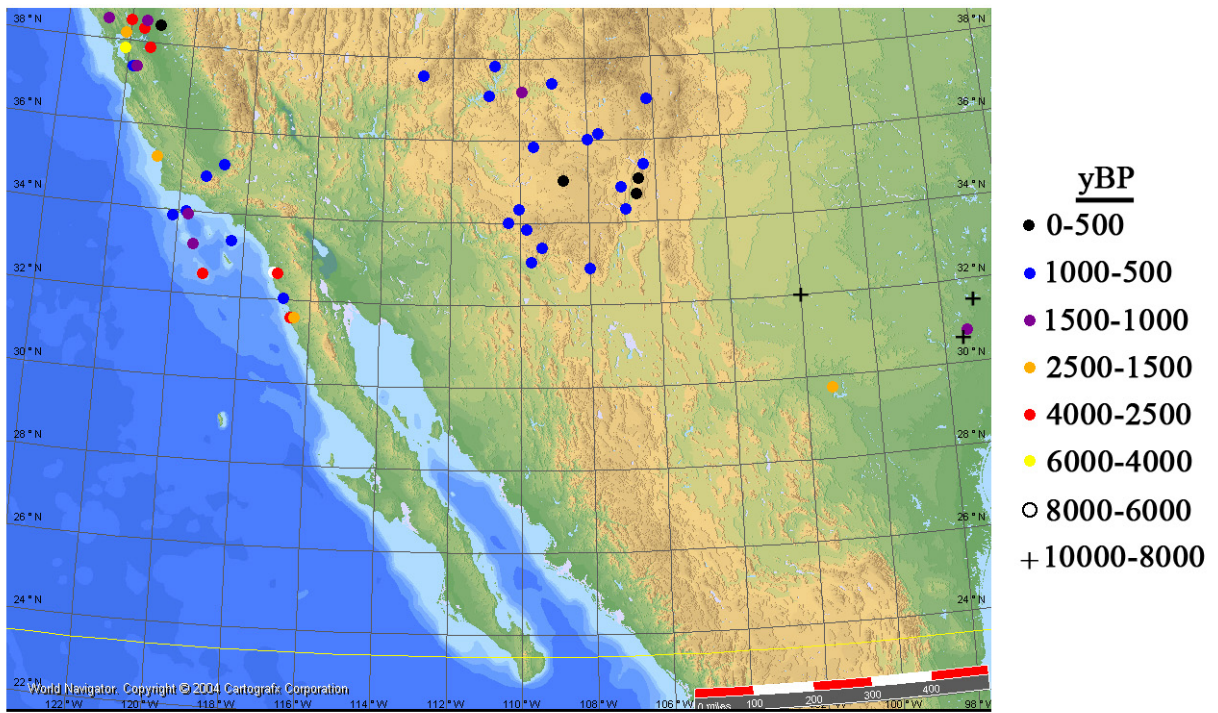


Figure A1.7 Southwestern central North America

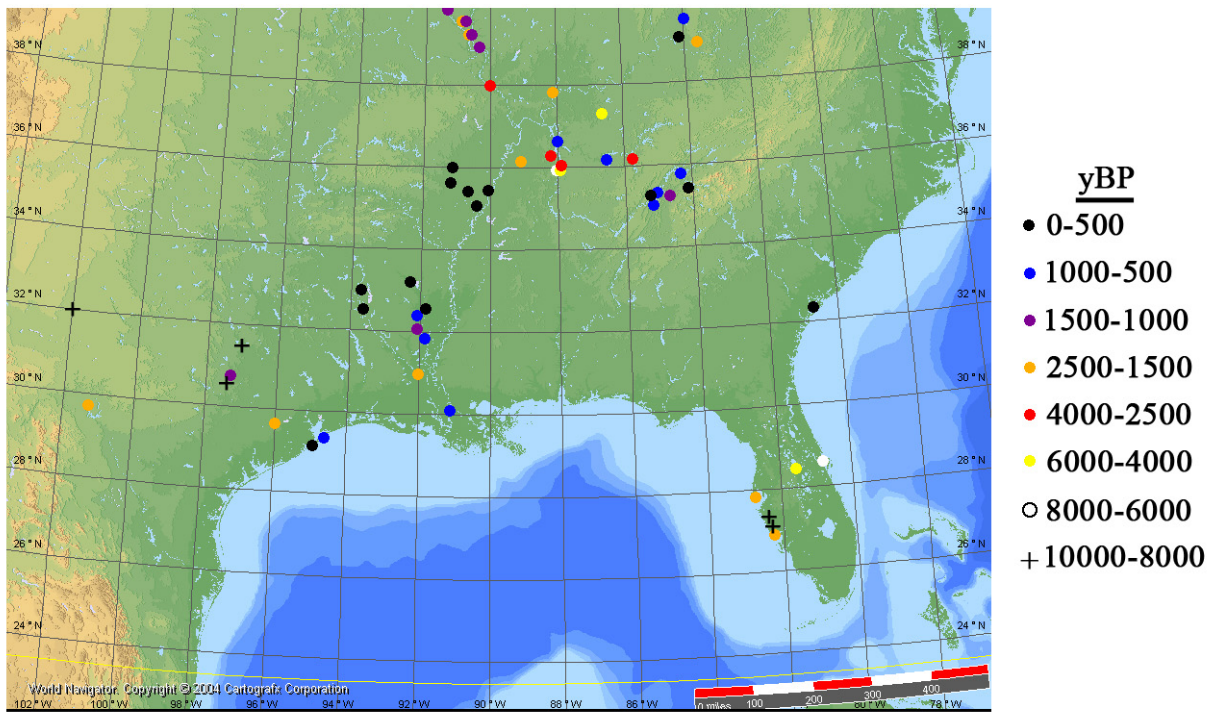


Figure A1.8 Southeastern central North America

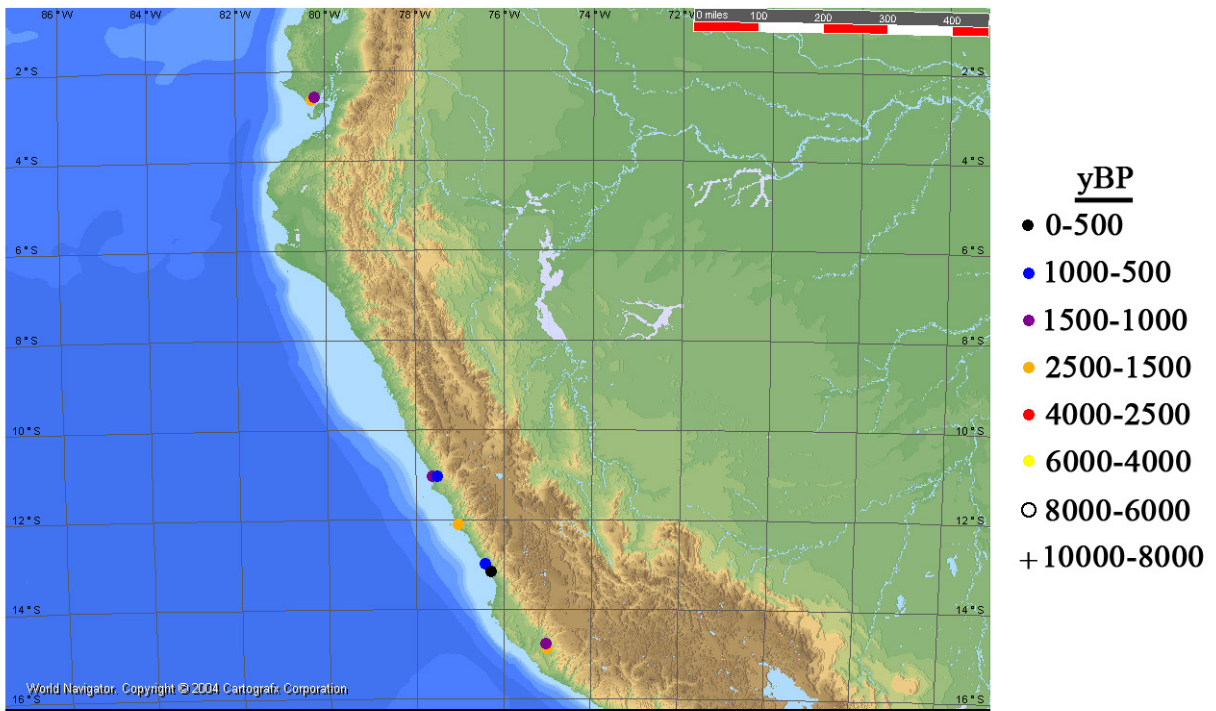


Figure A1.9 Northwestern central South America

Appendix II. Osteometrics¹

Measurement	Acronym	Reference	Instrument ²	Description
Basion-bregma	BBH	Martin (1928) #17; Howells (1973) BBH	Spreading calipers	Cranial maximum height: the maximum length from bregma (at the confluence of the coronal and sagittal sutures) to basion (at the anterior inferior margin of the foramen magnum, between the occipital condyles). Bregma is measured adjacent to the sutures, following Howells (1973), so any depression is not incorporated into the measurement. (<i>Figure A2.1</i>)
Glabella-opisthocranion	GOL	Martin (1928) #1; Howells (1973) GOL	Spreading calipers	Cranial maximum anteroposterior length: the maximum length from glabella (the most anteriorly projecting midline portion of the frontal bone, generally at the interaction of the superciliary arches in the midline) to opisthocranion (the most distant point of the occipital bone from glabella). In general, opisthocranion occurs either at the external occipital protuberance, or in line with the superior nuchal lines close to the sagittal (<i>not</i> parasagittal) plane. In cases of cranial deformation, this measurement is taken wherever the maximum cranial length occurs from the frontal to the occipital bones. (<i>Figure A2.1</i>)
Euryon-euryon	EUB	Martin (1928) #8, Howells (1973) XCB	Spreading calipers	Cranial maximum breadth: the maximum ectocranial breadth of the cranium. This dimension is taken on the parietals superior to the squamosal sutures, along the squamosal suture, or on the squamous portion of the temporal bones (avoiding taphonomic distortion of the squamous temporal). (<i>Figure A2.2</i>)
Prosthion-glabella	UFH	Martin (1928) #48	Sliding calipers	Upper face height: the superoinferior, sagittal length from glabella (as defined above) to prosthion (the most inferior and anteriorly-projecting point of the alveolar bone between the 1 st upper incisors). In archaeological specimens, erosion and edentulism were taken into account when the measurement was taken and noted. (<i>Figure A2.2</i>)
Rhinion-nasospinale	NAH	None	Sliding calipers	Nasal aperture height: the superoinferior, sagittal length from rhinion (the point at the most inferior, free portion of the nasal bones) to nasospinale (the midline point of the nasal aperture in line with the most inferior point of the inferior nasal aperture margin). Nasal bones are often broken in archaeological specimens, so this measurement is taken when possible and estimated when enough nasal bone was judged to be present. (Estimated measurements are noted in the data set.) Additionally, older individuals may have ossified nasal cartilage in the midline, so the measure is taken at the midpoint in line with the most superior point of the aperture. (<i>Figure A2.2</i>)

Measurement	Acronym	Reference	Instrument ³	Description
Alare-alar	NAB	Martin (1928) #54	Sliding calipers	Nasal aperture breadth: the widest point of the nasal aperture along the lateral margins. This was visually and instrumentally determined. (<i>Figure A2.2</i>)
Zygion-zygion	ZYB	Martin (1928) #55; Howells (1973) ZYB	Spreading calipers	Upper face breadth: the maximum width between the zygomatic arches. This measurement is occasionally estimated (and noted in the data set) in the case one zygomatic arch is broken; the hemi-breadth is measured, from zygion to the midline of the cranium (judged by the midline suture between the maxilla on the sub-nasal region or along the palate). (<i>Figure A2.2</i>)
Interclavicular facet breadth (jugular notch breadth)	JNB	None	Sliding calipers	The width between the articular facets of the clavicles on the superior margin of the manubrium. This approximates the distance between the sternal ends of the clavicles. (<i>Figure A2.3</i>)
Maximum clavicular length ³	CML	Martin (1928) #1	Osteometric board	Maximum length of the clavicles, from the most medial extreme of the sternal end to the most lateral extreme of the acromial end. This measurement is not taken with reference to the plane of the clavicular diaphysis. In cases of mild erosion on either end, measurements are estimated and noted. (<i>Figure A2.4</i>)
Clavicular 50% diaphyseal antero-posterior diameter ³	CAPD	Martin (1928) #5	Sliding calipers	The anteroposterior diameter of the clavicle perpendicular to the diaphysis at 50% (the midpoint) of the maximum length as determined by the CML measurement, at the same point as the CSID measurement. The clavicle is oriented so that the flattened acromial end is parallel to the plane of the measurement. (<i>Figure A2.4</i>)
Clavicular 50% diaphyseal superior-inferior diameter ³	CSID	Martin (1928) #4	Sliding calipers	The superior-inferior diameter of the clavicle perpendicular to the diaphysis at 50% (the midpoint) of the maximum length as determined by the CML measurement, at the same point as the CAPD measurement. The clavicle is oriented so that the flattened acromial end is perpendicular to the plane of the measurement. (<i>Figure A2.4</i>)
Maximum SI height of the centra of vertebrae C1 to L5 (or L6 if present)	XC# XT# XL#	Raxter et al. (2006)	Sliding calipers	The superior-inferior height of vertebral centra at the instrumentally- and visually-determined maximum along the anterior margin. Specific methods for each region of vertebrae are outlined in the appendix of Raxter et al. (2006), with the exception of C1. This element is measured superiorly on the margins of the articular facet for the dens of C2. All element measurements avoided including osteophytic growths and midline notches. Ankylosed elements were measured together and separately when possible. (<i>Figure A2.5</i>)

Measurement	Acronym	Reference	Instrument ³	Description
Anterior midline SI height of the centra of vertebrae C2 to L5 (or L6 if present)	MAC#	Modified from Martin (1928)	Sliding calipers	The superoinferior height of vertebral centra at the visually-determined midline (sagittal) point along the anterior margin. All element measurements avoided including osteophytic growths and midline notches. Ankylosed elements were measured together and separately when possible. (<i>Figure A2.5</i>)
	MAT#	#1		
	MAL#			
C2 height without dens	C2a	Modified from Martin (1928) #1b	Sliding calipers	The superoinferior height of C2 from the most inferior (non-pathological) point of the centrum to the point in line with the transverse plane of the superior articular facets. (<i>Figure A2.5</i>)
Maximum SI height of SI	XSI	Raxter et al. (2006)	Sliding calipers	The instrumentally-determined maximum superoinferior height of the first sacral vertebra (S1), from the sacral promontory to the point at which S1 articulates or is fused with S2. Like the other vertebral measurements, this is taken along the anterior aspect of the element, from the anterior margin of the promontory. Further description of the measurement is in the appendix of Raxter et al. (2006). (<i>Figure A2.6</i>)
Maximum sagittal SI height of the sacrum	SML	Martin (1928) #2	Sliding calipers	The maximum length of the sacrum from the anterior-superior rim (i.e., the promontory) to the most inferior anterior aspect of the last sacral vertebra (normally the fifth vertebra). In traumatized and older individuals, the coccyx is often fused to the fifth vertebra (S5); in these cases, the measurement was taken only to the suture line/ridge between S5 and the first coccygeal element. Sacral curvature variation is not taken into account by this measurement. (<i>Figure A2.6</i>)
Maximum humeral length ³	HML	Martin (1928) #1	Osteometric board	The maximum length of the humerus from the most superior point on the humeral head to the most distal point of the medial projection of the trochlea. In some instances, the greater tubercle projects superior to the most superior point of the humeral head, or the lateral projection of the trochlea is as long as or longer than the medial projection; when this is determined to not result from pathology or trauma, the measurement is taken from the most superior point of the proximal end of the humerus to the most distal point of the trochlea. (<i>Figure A2.7</i>)
SI humeral head diameter ³	HHD	Martin (1928) #10	Sliding calipers	The superoinferior length of the humeral head, measured between the margins of the anatomical neck. (<i>Figure A2.7</i>)
Humeral 50% diaphyseal medio-lateral diameter ³	HMLD	Martin (1928) #6b	Sliding calipers	At the 50% (midpoint) of the diaphysis, as determined from the measurement HML, the mediolateral diameter of the diaphysis. This is taken parallel to the plane between the medial and lateral epicondyles, and perpendicular to the long axis of the humeral diaphysis. (<i>Figure 3.7</i>)

Measurement	Acronym	Reference	Instrument ³	Description
Humeral 50% diaphyseal antero-posterior diameter ³	HAPD	Martin (1928) #6c	Sliding calipers	At the 50% (midpoint) of the diaphysis, as determined from the measurement HML, the anteroposterior diameter of the diaphysis. This is taken perpendicular to the plane between the medial and lateral epicondyles, perpendicular to the HMLD measurement, and perpendicular to the long axis of the humeral diaphysis. (Figure 3.7)
Maximum humeral epicondylar medio-lateral breadth ³	HEB	Martin (1928) #4	Osteometric board	The maximum breadth between the most extreme aspect of the medial epicondyle and the lateral epicondyle of the humerus, perpendicular to the axis of the humeral diaphysis. In cases of mild erosion on the condyles, this measurement is estimated and noted in the data set. (Figure A2.7)
Humeral capitulum-trochlea mediolateral breadth ³	HAB	Martin (1928) #12a	Sliding calipers	The mediolateral breadth of the distal articular surface of the humerus. This measurement is taken at the visually-determined anteroposterior midpoint of the trochlea and capitulum (see figure), and measured parallel to the plane of the axis between the epicondyles. (Figure A2.7)
Maximum radial length ³	RML	Martin (1928) #1	Osteometric board	The maximum length of the radius from the most superior point on the radial head to the most distal aspect of the styloid process. (Figure A2.8)
Radial 50% diaphyseal medio-lateral diameter ³	RMLD	Modified from Martin (1928) #4a	Sliding calipers	At the 50% (midpoint) of the diaphysis, as determined from the measurement RML, the mediolateral diameter of the diaphysis. This is taken perpendicular to the long axis of the radial diaphysis. The measurement includes the interosseous crest; instances where additional ossification of cartilage has added bone to the crest (as might be due to age or trauma) are noted but no visual correction of the measurement is attempted. When taphonomic processes have eroded the crest, no measurement is attempted. (Figure A2.8)
Radial 50% diaphyseal anteroposterior diameter ³	RAPD	Martin (1928) #5	Sliding calipers	At the 50% (midpoint) of the diaphysis, as determined from the measurement RML, the anteroposterior diameter of the diaphysis. This is taken perpendicular to the RMLD measurement, and perpendicular to the long axis of the radial diaphysis. (Figure A2.8)
Radial head mediolateral diameter ³	RMLH	Martin (1928) #4 (1)	Sliding calipers	The mediolateral diameter of the radial head, taken to the edges of the most superior aspect of the head that is not curving inward to the articular surface, with calipers held parallel to the plane of the superior surface of the head (e.g., at the same angle as the head). This measurement is taken in the same plane as the RMLD measurement. (Figure A2.8)

Measurement	Acronym	Reference	Instrument ³	Description
Radial head anteroposterior diameter ³	RAPH	Martin (1928) #5 (1)	Sliding calipers	The anteroposterior diameter of the radial head, taken to the edges of the most superior aspect of the head that is not curving inward to the articular surface, with calipers held parallel to the plane of the superior surface of the head (e.g., at the same angle as the head). This measurement is taken in the same plane as the RAPD measurement. (<i>Figure A2.8</i>)
Distal radial articular surface mediolateral breadth ³	RAB	Ruff (2002b) HDML	Sliding calipers	The mediolateral breadth of the distal articular surface of the radius, taken from the visually-determined midpoint of the inferior edge of the ulnar notch to the lateral edge of the articular surface (not to the lateral edge of the styloid process). (<i>Figure A2.8</i>)
Ulnar maximum length ³	UML	Martin (1928) #1	Osteometric board	The maximum length of the ulna, from the most superior point of the proximal portion of the olecranon to the most distal aspect of the styloid process. Measurements of this dimension do not include any ossified triceps brachii tendon (due to age or pathology) that projects above the most superior aspect of the olecranon. In cases where the styloid process is mildly eroded, the measurement is estimated and noted in the data set. (<i>Figure A2.9</i>)
Ulnar 50% diaphyseal mediolateral diameter ³	UMLD	None	Sliding calipers	At the 50% (midpoint) of the diaphysis, as determined from the measurement UML, the mediolateral diameter of the diaphysis, perpendicular to the long axis of the diaphysis and parallel to the plane of the trochlear notch. (<i>Figure A2.9</i>)
Ulnar 50% diaphyseal anteroposterior diameter ³	UAPD	None	Sliding calipers	At the 50% (midpoint) of the diaphysis, as determined from the measurement UML, the anteroposterior diameter of the diaphysis. This is taken perpendicular to the long axis of the ulnar diaphysis, perpendicular to the UMLD measurement, and in the same plane as the guiding ridge of the trochlear notch. The measurement includes the interosseous crest; rare instances where additional ossification of cartilage has added bone to the crest (as might be due to age or trauma) are noted but no visual correction of the measurement is attempted. When taphonomic processes have eroded the crest, no measurement is attempted. (<i>Figure A2.9</i>)
Femoral maximum length ³	FML	Martin (1928) #1	Osteometric board	Femoral maximum length, from the most superior point on the femoral head to the most inferior aspect of the medial condyle. In instances in which the greater trochanter projects superior to the most superior point of the femoral head, even if not perceptibly due to trauma or pathology, no measurement is attempted. (<i>Figure A2.10</i>)

Measurement	Acronym	Reference	Instrument ³	Description
Femoral bicondylar (physiological) length ³	FBL	Martin (1928) #2	Osteometric board	Femoral “physiological” length, in which the condyles are placed flat against one end of the osteometric board, so that the inferior aspects of both condyles contact the vertical plane of the board in line with each other. The measurement is taken from this distal aspect of the condyles to the most proximal aspect of the femoral head (e.g., the point yielding the maximum measurement). Femora that are excluded from the FML measurement are likewise excluded from this measurement. (<i>Figure A2.10</i>)
Femoral head anteroposterior diameter ³	FHD	Martin (1928) #19	Sliding calipers	The anteroposterior diameter of the femoral head, measured with an orientation perpendicular to the long axis of the femoral diaphysis, with the femur held vertically. (<i>Figure A2.10</i>)
Femoral 50% diaphyseal medio-lateral diameter ³	FMLD	Martin (1928) #7	Sliding calipers	At the 50% (midpoint) of the diaphysis, as determined from the measurement of FML, the mediolateral diameter of the femoral diaphysis. This is taken perpendicular to the long axis of the femoral diaphysis and in the same plane as the horizontal axis through the epicondyles. (<i>Figure A2.10</i>)
Femoral 50% diaphyseal anteroposterior diameter ³	FAPD	Martin (1928) #6	Sliding calipers	At the 50% (midpoint) of the diaphysis, as determined from the measurement of FML, the anteroposterior diameter of the femoral diaphysis. This is taken perpendicular to the plane of the FMLD measurement and perpendicular to the long axis of the diaphysis. The linea aspera is included in this measurement. (<i>Figure A2.10</i>)
Femoral epicondylar breadth ³	FEB	Martin (1928) #21	Osteometric board	The mediolateral breadth of the epicondyles perpendicular to the long axis of the femoral diaphysis. The epicondyles are often mildly eroded in archaeological specimens, and in such instances the measurement is estimated and noted in the data set. (<i>Figure A2.10</i>)
Femoral distal articular (bicondylar) mediolateral breadth ³	FAB	Ruff (2002b) FCML	Sliding calipers	The mediolateral breadth of the condyles, from the most lateral and posterior projection of the lateral condyle to the most medial and posterior projection of the medial condyle. In cases of mild erosion, this measurement is taken and noted in the data set. (<i>Figure A2.10</i>)
Tibial maximum length ³	TML	Martin (1928) #2	Osteometric board	The maximum length of the tibia, taken from the most superior point of the intercondylar eminence (“spines”) to the most distal aspect of the medial malleolus. The axis of the diaphysis is oriented so that it is parallel to the long axis of the measurement. (<i>Figure A2.11</i>)

Measurement	Acronym	Reference	Instrument ³	Description
Tibial “Fully technique” length ³	TFL	Martin (1928) #1; Raxter et al. (2006)	Osteometric board	The length of the tibia not including the intercondylar eminence. This is measured from the medial malleolus to the lateral condyle of the tibia, with the long axis of the measurement parallel to the axis of the tibial diaphysis. See Raxter et al. (2006) for further description of the measurement technique. (Figure A2.11)
<p>Note that this measurement is taken using a board with a track (e.g., the mobile end is fixed and not freely moveable), so the TFL measurements were taken with the mobile end slightly offset and the tibia held to one side of the board (rather than in the center). This results in a one millimeter overestimation of TFL, which is subsequently corrected in the data set.</p>				
Tibial plateau mediolateral (bicondylar) breadth ³	TPB	Martin (1928) #3	Osteometric board	The mediolateral breadth of the tibial plateau, including the medial and lateral cortical projections of the condyles beyond the articular surfaces. This measurement is taken with the axis of the measurement passing through the visually-determined anteroposterior midpoint of the condyles. (Figure A2.11)
Tibial proximal articular mediolateral breadth ³	TPAB	Ruff (2002b) TPML	Sliding calipers	The mediolateral breadth of the proximal articular surface of the tibia. This measurement is taken in the identical plane as the TPB measurement, and also at the visually-determined anteroposterior midpoint of the condyles. However, the measurement is taken only to the edges of the articular surfaces of the condyles, and does not include any of the bone medial or lateral to the edges of the medial or lateral articular surfaces, respectively. (Figure A2.11)
Tibial 50% diaphyseal mediolateral diameter ³	TMLD	None	Sliding calipers	At the 50% (midpoint) of the diaphysis, as determined from the measurement TML, the mediolateral diameter of the tibial diaphysis. This is taken perpendicular to the long axis of the femoral diaphysis and in the same plane as the horizontal axis through the tibial plateau used in the TPB and TPAB measurements. The tibial diaphysis is generally triangular in cross-section at the point of this measurement, so the measurement is taken relative to the orientation of the plateau and not diaphyseal shape. (Figure A2.11)
Tibial 50% diaphyseal anteroposterior diameter ³	TAPD	None	Sliding calipers	At the 50% (midpoint) of the diaphysis, as determined from the measurement TML, the anteroposterior diameter of the tibial diaphysis. This dimension is taken perpendicular to the long axis of the femoral diaphysis and perpendicular to the plane of the TMLD measurement. The tibial diaphysis is generally triangular in cross-section at the point of this measurement, so the measurement is taken relative to the orientation of the plateau (as the TMLD measurement is aligned) and not diaphyseal shape. (Figure A2.11)

Measurement	Acronym	Reference	Instrument ³	Description
Tibial distal articular (tibiotalar) surface mediolateral breadth ³	TDML	Ruff (2002b) TTML	Sliding calipers	Taken at the visually-determined anteroposterior midpoint of the tibiotalar surface, the breadth of the distal tibial articular surface from the medial edge (not including the malleolus) to the lateral border of the articular surface. This measurement is taken in the same plane as the TPB, TPAB, and TMLD measurements. The medial edge of the measurement is visually determined as the midpoint of the curve between the articular surface at the horizontal base of the tibia and the surface on the lateral aspect of the medial malleolus. The lateral edge of the measurement avoids any flexure created by the inferior fibular articular surface. (<i>Figure A2.11</i>)
Tibial distal articular (tibiotalar) surface midpoint anteroposterior breadth ³	TDAP	Ruff (2002b) TTAP	Sliding calipers	At the mediolateral midpoint of the tibiotalar surface, as determined from the TDML measurement, the anteroposterior breadth of the distal tibial articular surface. This measurement is taken in the same plane as the TAPD measurement and perpendicular to the TDML measurement. This measurement is taken only to the edge of the articular surface and avoids any proximal curvature of the surface. (<i>Figure A2.11</i>)
Tibial distal articular (tibiotalar) surface maximum anteroposterior breadth ³	TDAX	None	Sliding calipers	In the same plane as the TDAP measurement, this is the widest anteroposterior breadth of the tibiotalar surface. Generally, this occurs on the lateral margin of the articular surface. As in the TDAP measurement, any proximal curvatures of the articular surface are avoided. (<i>Figure A2.11</i>)
Fibular maximum length ³	FIML	Martin (1928) #1	Osteometric board	The maximum length of the fibula, measured between the most distal aspect of the lateral malleolus to the most proximal point of the styloid process, with the long axis of the bone parallel to the axis of the measurement. (<i>Figure A2.12</i>)
Maximum iliac blade length ³	IBL	Martin (1928) #12	Spreading calipers	The length of the iliac blade from the most anterior projection of the anterior superior iliac spine (ASIS) to the most posterior projection of the posterior superior iliac spine (PSIS). Any erosion or breakage of these spines precludes this measurement.

Measurement	Acronym	Reference	Instrument ³	Description
Maximum acetabular height ³	ACH	None	Sliding calipers	The length of the internal aspect of the acetabulum, on the lunate surface, measured from the most inferior aspect of the lower rim (generally the point closest to the ischial tuberosity) to the opposite side of the acetabulum (generally the point closest to the anterior inferior iliac spine), so this dimension constitutes a diameter. This measurement is taken within the acetabulum, to the external edge of the lunate surface. Note that this measurement does not reflect any anatomical orientation of the acetabulum (e.g., superior/inferior or anterior/posterior).
Bi-iliac breadth	BIB	Martin (1928) #2	Osteometric board	This is the transverse (coronal) breadth of the articulated pelvis between the iliac (crystal) tubercles. The pelvis is articulated by matching the sacral auricular surfaces to the corresponding auricular surfaces of the os coxae. The pubic symphyses are articulated as well, and the sacral articulations are adjusted so that the sacrum fits as a keystone between the os coxae. (<i>Figure A2.13</i>)
Talus-calcaneus height ³	TCH	Raxter et al. (2006)	Osteometric board	In most archaeological specimens, the pubic bones have broken away from the remainder of the os coxae, and so the pubic symphysis is not present. In other instances, only one os coxa may be present or intact to allow for this measurement. When the pubic bones are broken, the measurement is taken and the lack of the pubic bone is noted in the data set. When only half of the pelvis is measurable, a hemi-pelvic measurement is taken (wherein the measurement is taken from the crystal tubercle to the midpoint of the sacrum, which is placed parallel to the surface of the osteometric board) and this value is doubled. This estimate is also noted in the data set. (<i>Figure A2.13</i>)
				The height of the articulated talus and calcaneus, from the most inferior point of the calcaneal tuber to the visually-determined point of the ninety-degree tangent of the anteroposterior midpoint of the superior aspect of the talar trochlea. The articulation of the talus and the calcaneus is described more specially in the appendix of Raxter et al. (2006). Both the medial and lateral edges of the superior surface of the talar trochlea must contact the vertical plane of the osteometric board. (<i>Figure A2.14</i>)

Measurement	Acronym	Reference	Instrument ³	Description
Talar trochlea anteroposterior midpoint breadth ³	TTB	Martin (1928) #5	Sliding calipers	The mediolateral breadth of the talar trochlea at the anteroposterior midpoint. This measurement is taken at the same point as the tangent used for the point of contact for the talar trochlea in the TCH measurement. Only the most superior edges of the articular surface of the trochlea are incorporated into this measurement; the inferiorly curving edges of the articular surface are avoided in this measurement. (<i>Figure A2.14</i>)

¹ Not all osteometrics listed here are employed in the analyses conducted in this dissertation. However, as all of these measurements are taken whenever possible throughout the data set, descriptions of all measurements are listed here for comprehensiveness.

² All measurement tools take measurements between two parallel planes aligned by fixed tracks. (E.g., no trackless osteometric boards are used in this data collection.) Sliding calipers measure to the nearest 0.01 mm. Osteometric board measurements are taken to the nearest 0.5 mm, and spreading caliper measurements are to the nearest 1 mm.

³ Measurements are taken bi-laterally (e.g., on left-side and right-side elements) whenever possible.

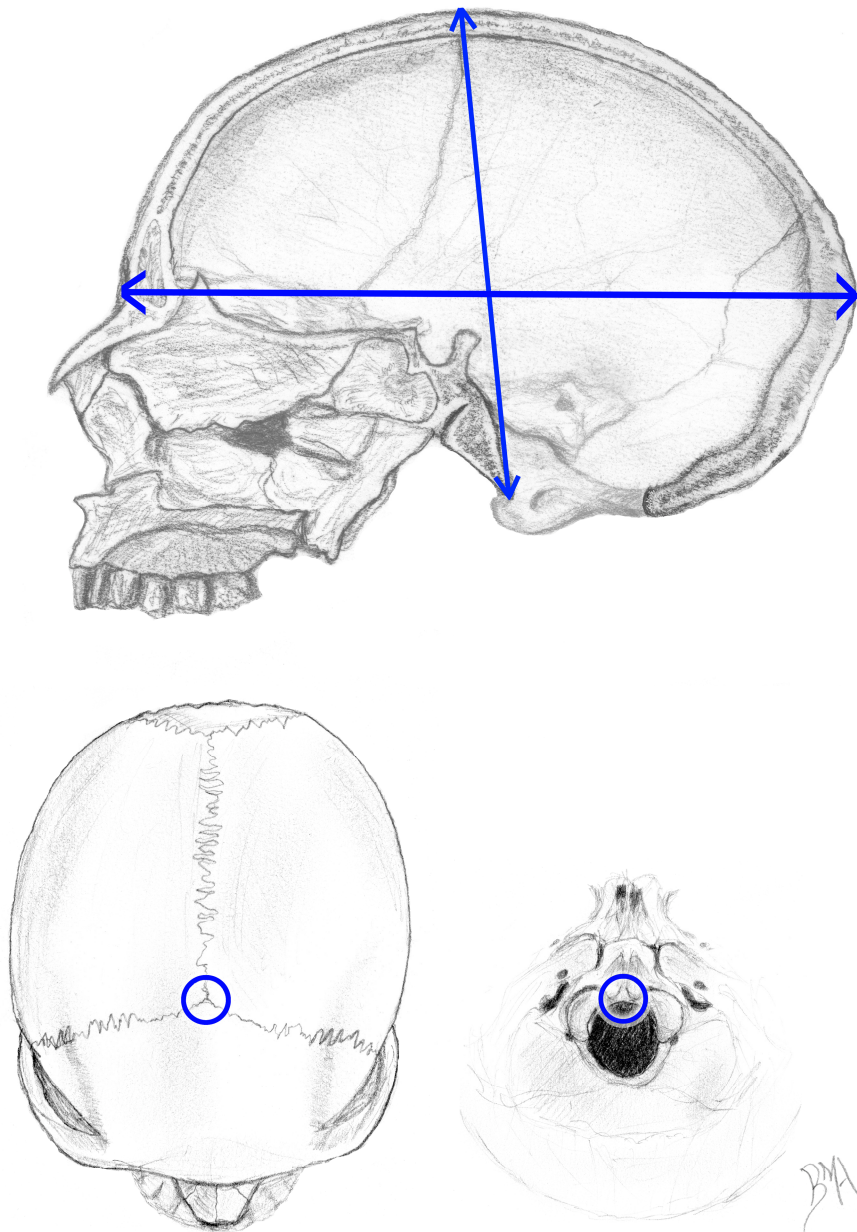


Figure A2.1. Basion-bregma and glabella-opisthocranium cranial measurements.

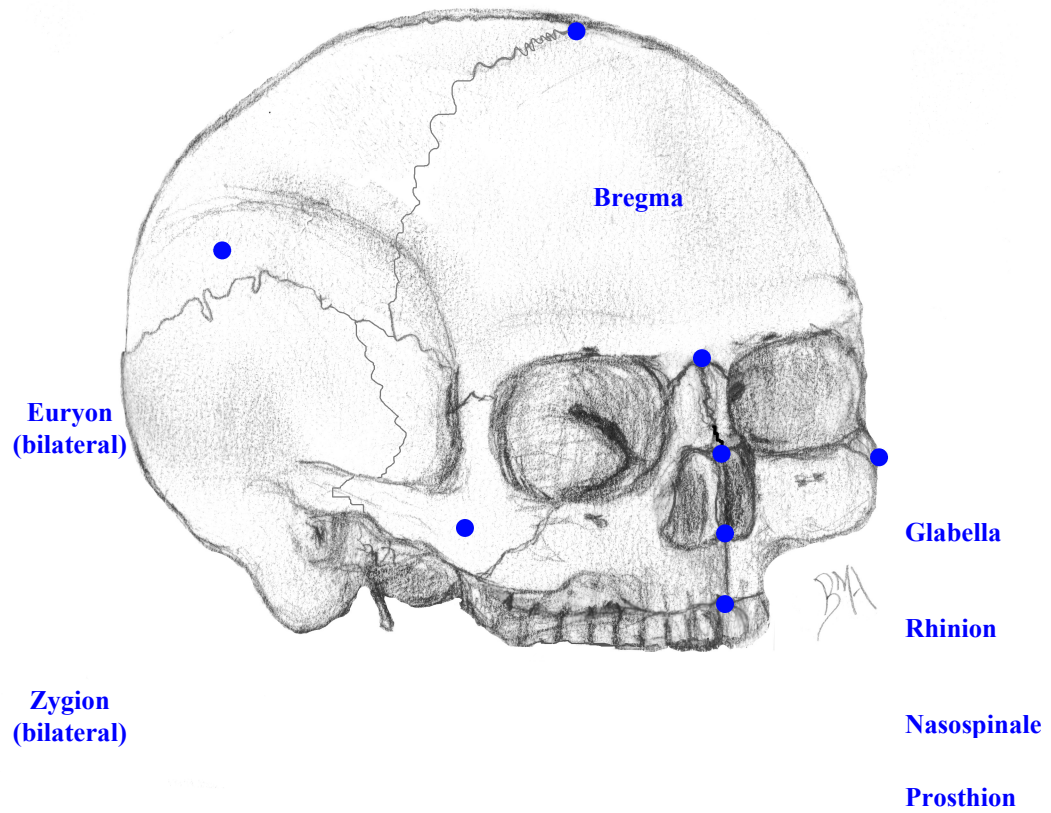


Figure A2.2. Cranial landmarks. All cranial landmarks except basion and opisthocranium (see Figure A2.1) are designated. Landmarks are indicated with blue dots, and names are located alongside the cranium at the same level as the landmarks. Both zygion points are shown, though only one (the anatomical right side) is labeled.

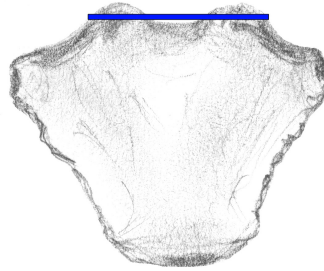


Figure A2.3. Manubrium measurement.

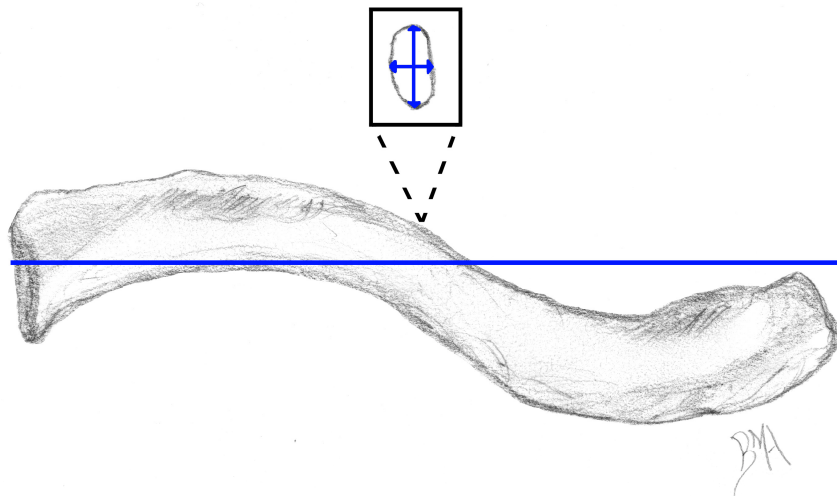


Figure A2.4. Clavicle measurements. Diaphyseal midshaft diameters are shown in the box above the clavicle (top of the box is anterior).

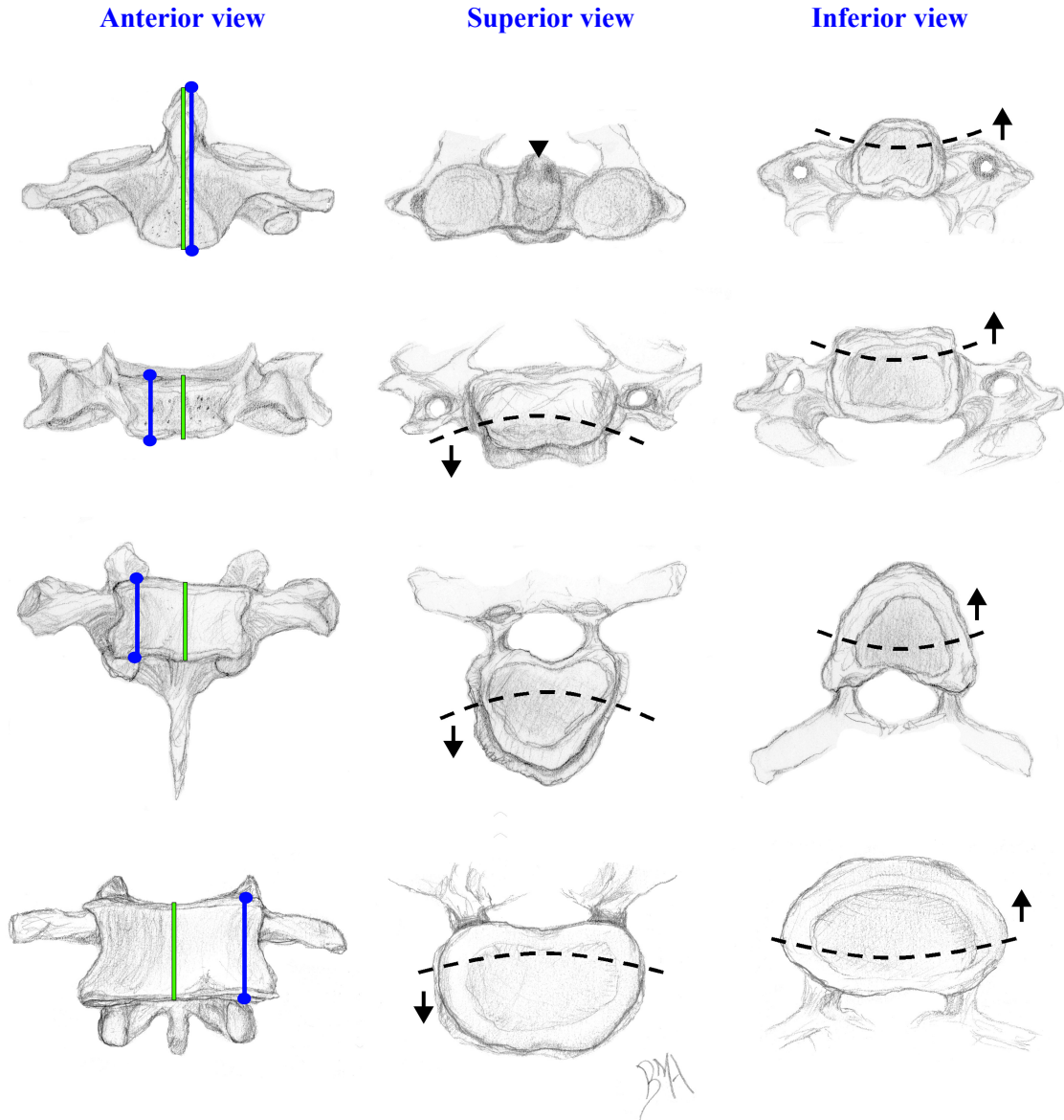
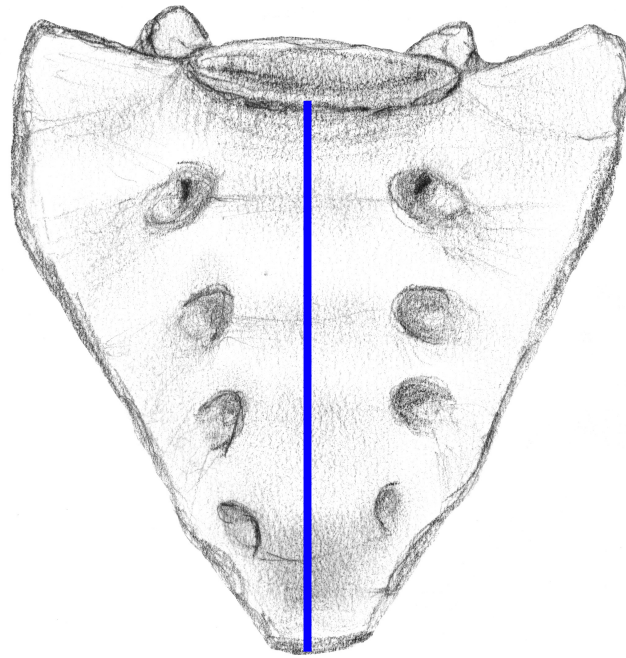


Figure A2.5. Cervical through lumbar vertebra measurements. The topmost vertebra is C2; the remaining vertebrae, from top to bottom, are representatives of cervical, thoracic, and lumbar vertebrae. Green lines indicate anterior midline centrum measurements. Blue lines represent maximum anterior centrum measurements. Superior and inferior views indicate the location on the centrum margin eligible for caliper placement in taking maximum anterior centrum measurements.



Anterior view

Superior view

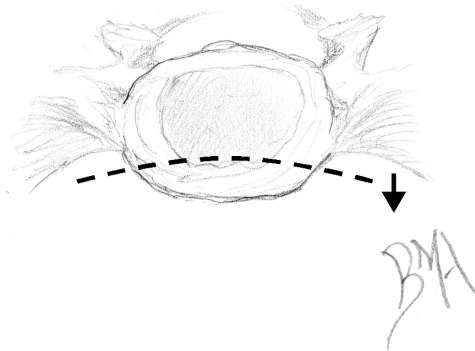
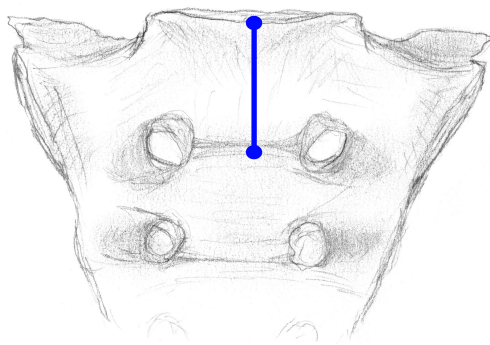


Figure A2.6. Sacrum measurements. The top diagram depicts the measurement of maximum sagittal superoinferior height of the sacrum. The bottom pair of diagrams depict the maximum superoinferior height of S1, and the superior region of S1 (the promontory) eligible for caliper placement when taking the measurement.

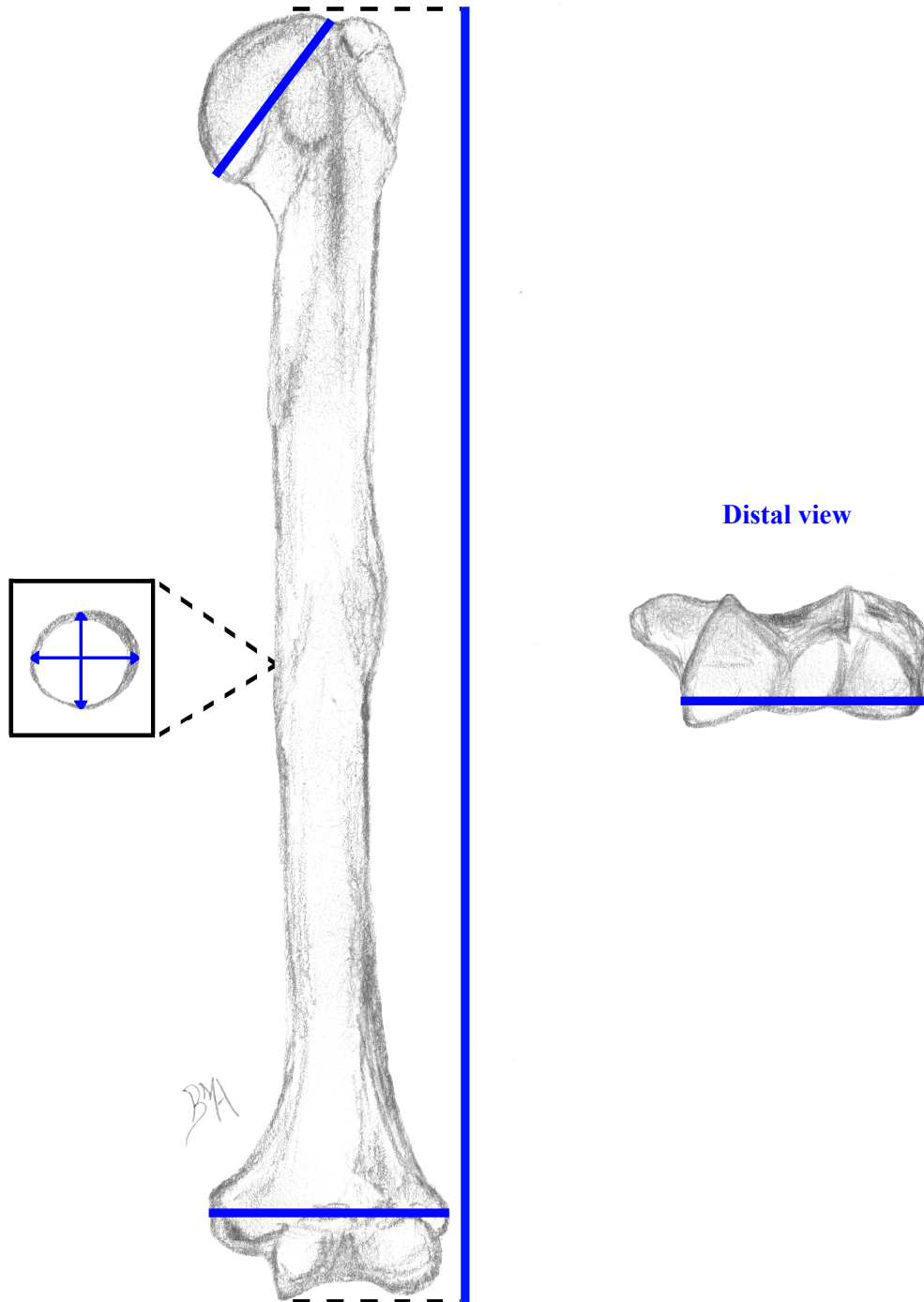


Figure A2.7. Humerus measurements. Diaphyseal midshaft diameters are shown in the box to the left of the humerus (top of the box is posterior). A distal view of the trochlea and capitulum of the humerus is shown to the right, with the HAB measurement.

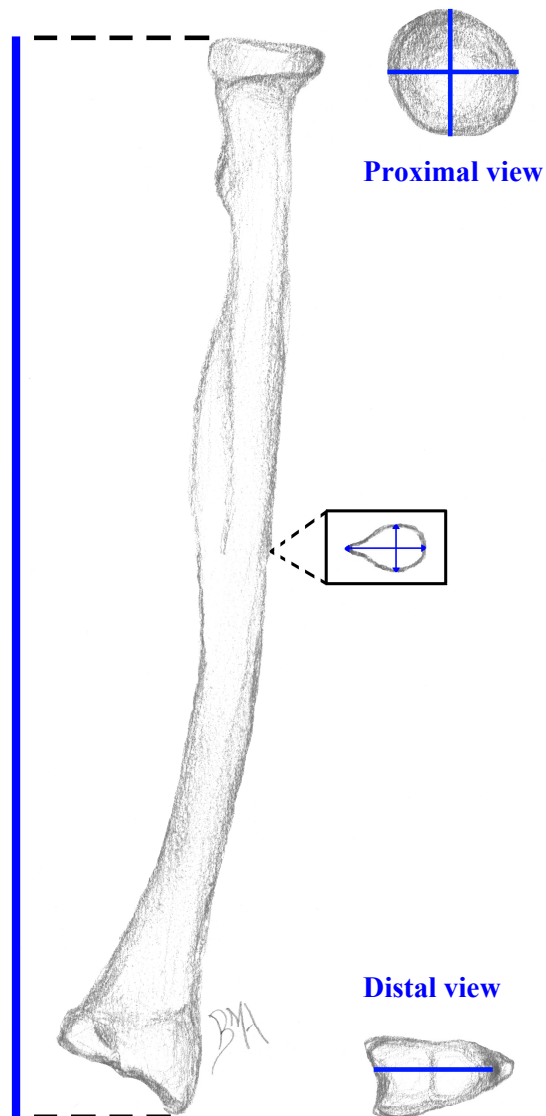


Figure A2.8. Radius measurements. Diaphyseal midshaft diameters are shown in the box to the right of the radius (top of the box is posterior). The radial head and its two measurements (RMLH and RAPH) are depicted to the upper right of the radius. The distal view of the radius and the RAB measurement are shown in the lower right of the diagram.

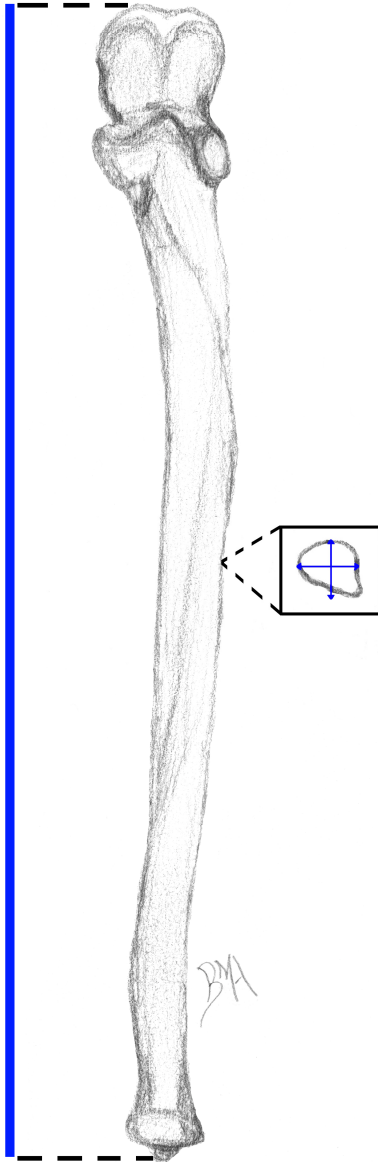


Figure A2.9. Ulna measurements. Diaphyseal midshaft diameters are shown in the box to the right of the ulna (top of the box is posterior).

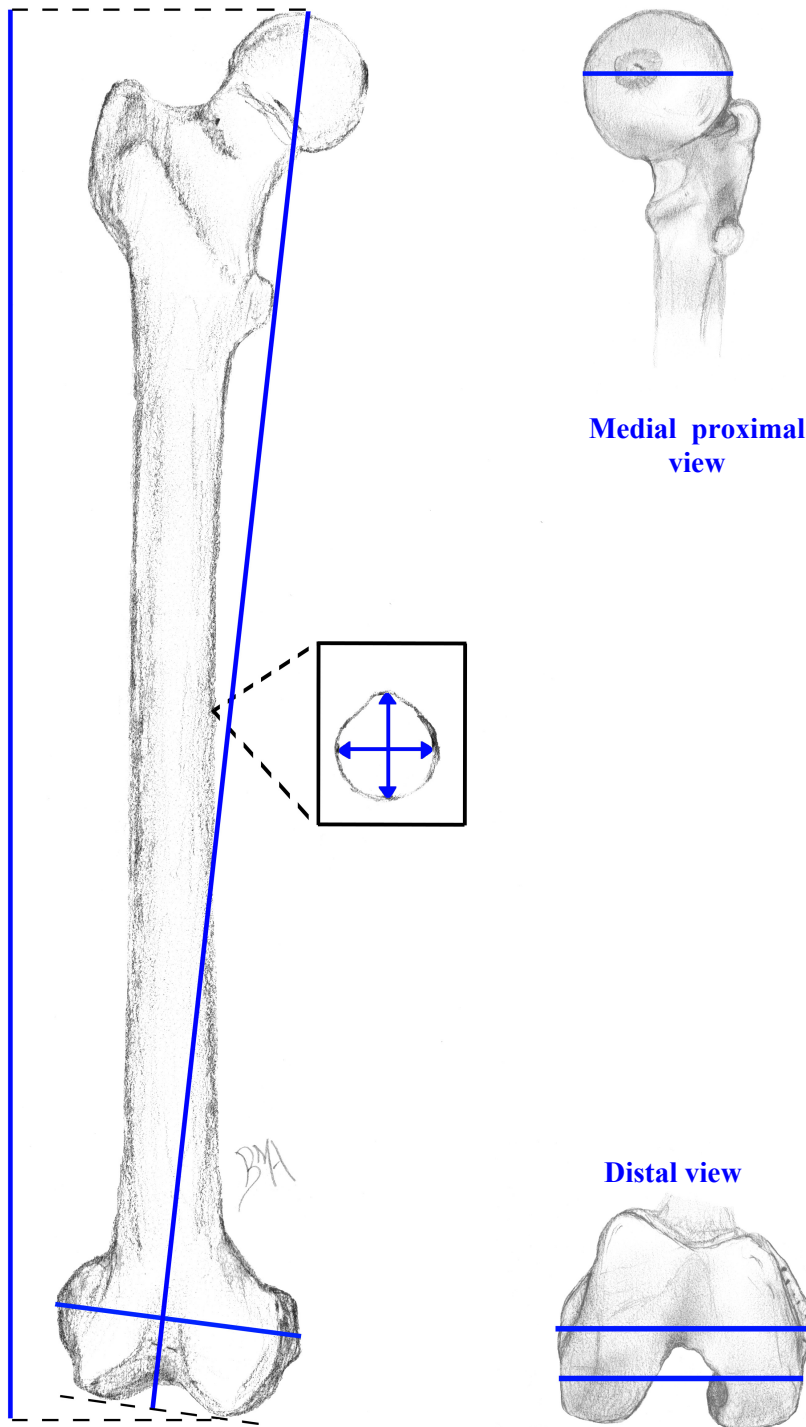


Figure A2.10. Femur measurements. Both maximum and bicondylar length measurements are shown to the left. Diaphyseal midshaft diameters are shown in the box to the right of the femur (top of the box is posterior). The anteroposterior femoral head measurement is depicted to the upper right, and condyle measurements (FEB and FAB) to the lower right.

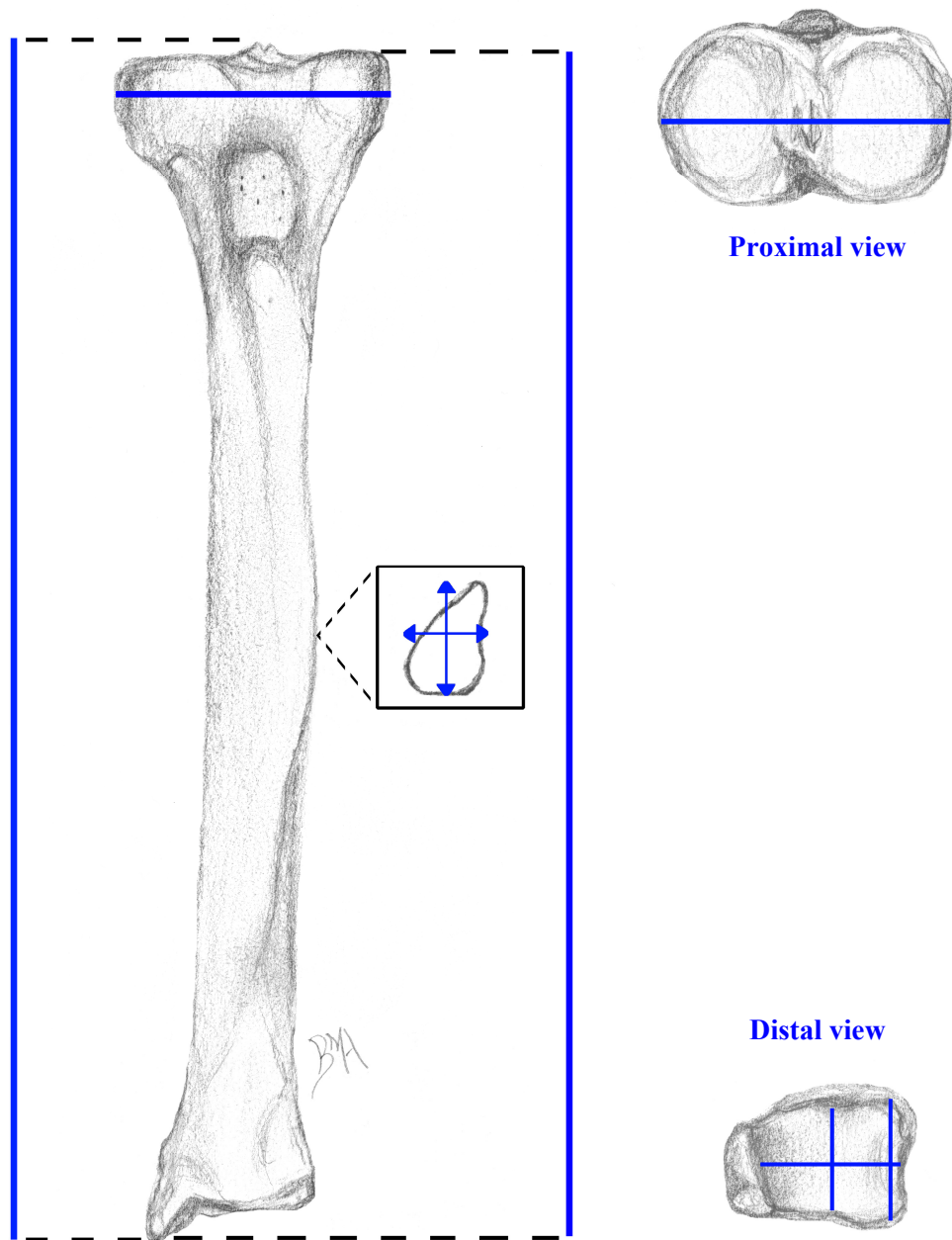


Figure A2.11. Tibia measurements. Both maximum length (blue line to the left of the tibia) and Fully technique length (blue line to the right of the tibia) are depicted. Diaphyseal midshaft diameters are shown in the box to the right of the tibia (top of the box is anterior). The proximal view of the tibia and the TPAB measurement are to the upper right of the diagram. The distal view and associated articular surface measurements are to the lower right.

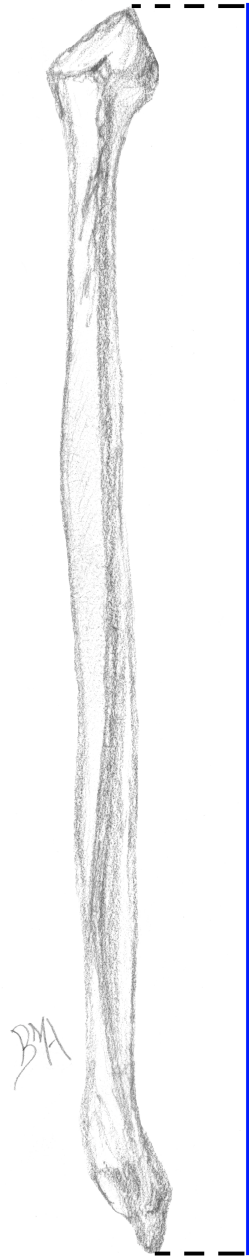


Figure A2.12. Fibula measurement.

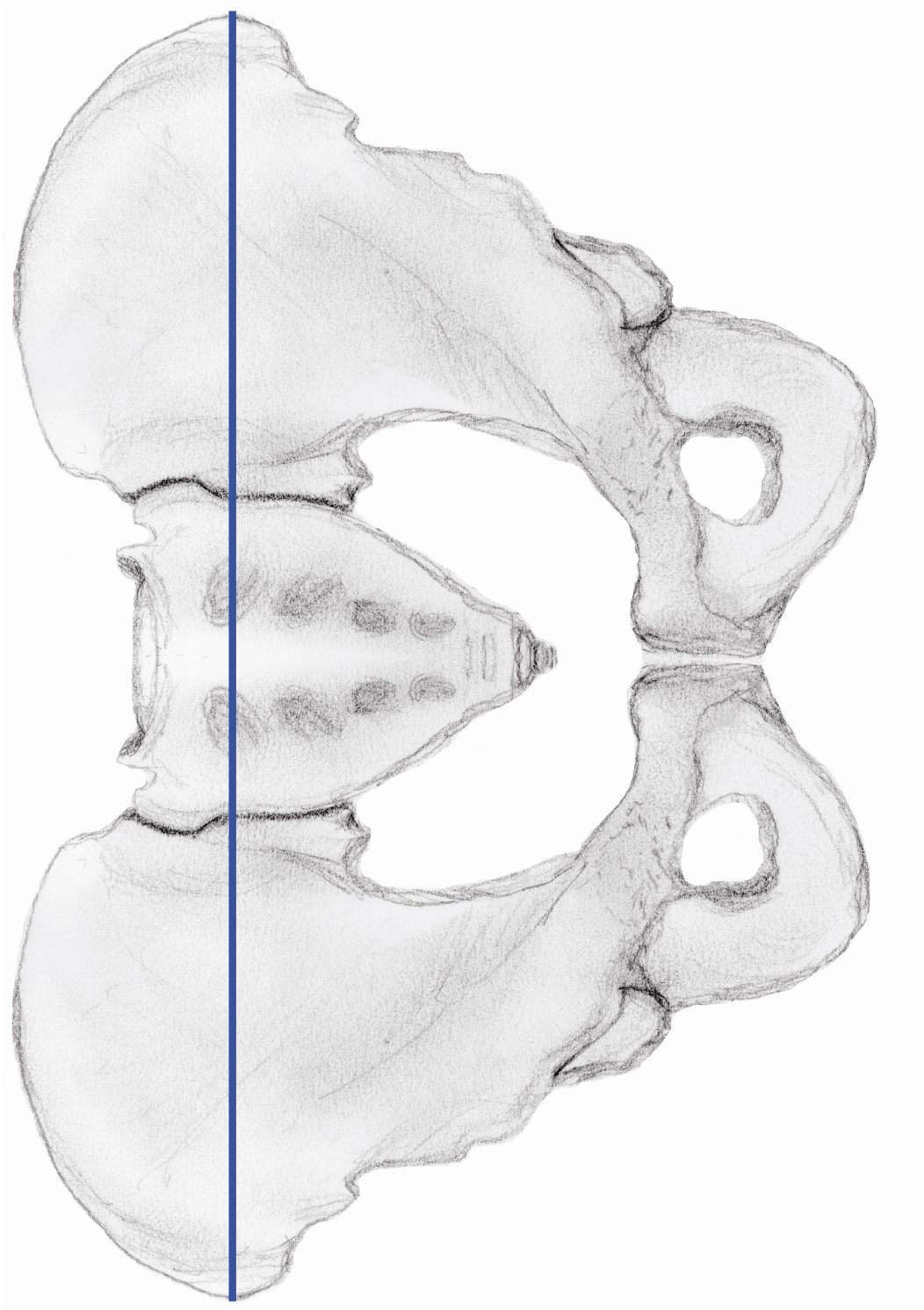


Figure A2.13. Os coxae measurements.

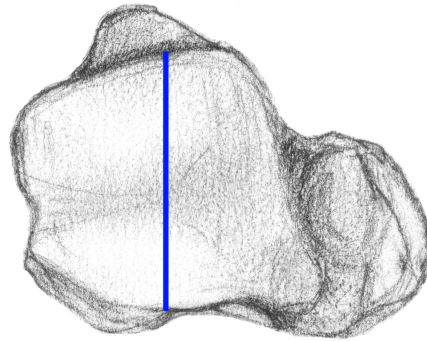
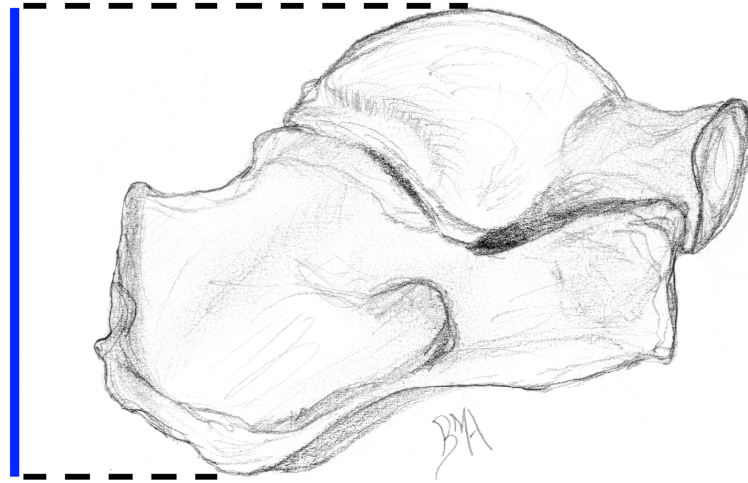


Figure A2.14. Tarsal measurements. The top diagram depicts articulated talocalcaneal height. The bottom diagram shows the mediolateral trochlear articular measurement of the talus.

Appendix III. Derived morphology and proportion equations

Notes: See Appendix II for definitions of the measurements and their abbreviations. Some derived morphologies may be calculated using more than one formulaic approach, as described in Chapter 4. Note that not all equations presented in this appendix are utilized. Each alternative formula is reported in this chapter with a parenthetical number to indicate that more than one equation is reported for that morphology. In addition, each is listed with its abbreviation in parentheses, employed in the tables of Chapter 6.

¹ In these postcranial measurements, the bilateral average for the limbs is used to minimize the effects of bilateral asymmetry. (E.g., HML equals the average of the maximum lengths for the left and right humeri.)

² Holliday's (1995) method for calculating trunk height included the ventral maximum length of the sacrum (SML), in addition to the heights of the thoracic and lumbar vertebrae. SML was not measurable, however, in half of the sample, and so requiring its inclusion in this formula would greatly limit the sample. (SML cannot be reliably estimated from any other measurements.) In addition, the anatomical overlap of the proximal femur and the distal portion of the sacrum may overestimate the length of the torso were the SML included, despite Holliday's contention that it does not in his dissertation (1995). See Chapter 4, "Derived Morphologies" for further discussion.

³ The orientation of the clavicles in the upper torso is variable, but the clavicles are never positioned in the same transverse plane as the manubrium. Without radiographs taken from a living individual, the orientation of the clavicles currently cannot be reconstructed from skeletal elements alone. Therefore, this derived morphology does not reflect the anatomical bi-clavicular breadth of a living person, but rather acts as a proxy for that dimension. See Chapter 4, "Derived Morphologies" for further discussion.

Cranial morphology

Cranial Index: $\text{EUB} \div \text{GOL} \times 100$
(CRI) Describes relative breadth of the cranium, and therefore its "shape," comparable to cephalic index, which is an anthropometric measurement taken from living subjects. Higher cranial indices indicate rounder—or more brachiocephalic—crania. Lower cranial indices indicate narrower—or more dolichocephalic—crania.
References: Beals, 1972; Beals et al., 1983; Little et al., 2006

Cranial "Size": $(\pi \times \text{EUB}/2 \times \text{GOL}/2)^2$
Equals a rough estimate of cranial external area, modeled as an ellipse, and therefore provides one measurement of cranial size. See Chapter 4 for its use versus cranial module. BBH is not measurable as often as EUB and GOL; cranial "area" has a high correlation with cranial size ($r = 0.882$).
Reference: adapted from Reinbold et al., 1985

Cranial “Module”: **(EUB + GOL + BBH) ÷ 3**
 (CRM) Yields a rough proxy for cranial capacity, though it is a two-dimensional measurement (rather than the cubic cranial capacity). The correlation of “module” and “size” is very high ($r = 0.99$), as is expected given the values in determining each are the same, but module is preferred in analyses due to reasons explained in Chapter 4.
 References: Hrdlička, 1925; Beals et al., 1984; Reinbold et al., 1985

Nasal Index:
 (NI) **NAB ÷ NAH × 100**
 The breadth of the nasal aperture, relative to its height. This is a slight modification of the more commonly employed proportion, which uses nasion-to-nasospinale for nasal height, in an attempt to better represent the external nasal aperture proportions.
 References: Montagu, 1960; Franciscus and Long, 1991

Facial Index:
 (FI) **ZYB ÷ UFH × 100**
 The breadth of the upper face, relative to its height.
 References: Cameron, 1929; Montagu, 1960; Newman, 1953; Crognier, 1981

Postcranial morphology

Average Diaphyseal
 Diameters: **(CMLD + CAPD) ÷ 2; (HMLD + HAPD) ÷ 2; (RMLD + RAPD) ÷ 2; (UMLD + UAPD) ÷ 2; (FMLD + FAPD) ÷ 2; (TMLD + TAPD) ÷ 2**
 Although some diaphyseal breadths at 50% of the total element length are nearly circular (especially for the femur), most are not as a result of bone shape response to genetic and mechanical factors. The direction of primary loading is different among these bones, and so comparing anteroposterior diameters among them is confounded by their mechanical properties. The averaging of the two planar diameters allows for the direct comparison of all elements.
 Reference: Auerbach and Ruff, 2006

Brachial Index¹: **RML ÷ HML × 100**
 (BI) The relative length of the forearm (with RML as a proxy) to the length of the arm (with HML as a proxy).
 References: Trinkaus, 1981; Ruff, 1994a; Holliday, 1999

Crural Index¹: **TML ÷ FBL × 100**
 (CI) The relative length of the leg (with TML as a proxy) to the length of the thigh (with FBL as a proxy).
 References: Davenport, 1933; Holliday, 1999

- Interlimb Index: **$(HML + RML) \div (FBL + TFL) \times 100$**
 (ILI) The length of the upper limb (*sans* hand) relative to the physiological length of the lower limb (*sans* foot).
 Reference: Porter, 1999
- Relative Torso Height (1)^{1, 2}: **$(\Sigma XT1 \text{ through } XL5) \div (FBL + TFL) \times 100$**
 (RTH) An approximation of the relative length of the torso to the length of the major lower limb bones (alternatively, the relative length of the lower limb). Many skeletons lack the all of the elements necessary for the second method (see below), and this yields similar results.
 Reference: Holliday and Trinkaus, 1991; Holliday, 1995
- Relative Upper Limb Length/Torso Height^{1, 2}: **$(HML + RML) \div (\Sigma XT1 \text{ through } XL5) \times 100$**
 (ULTH) The length of the upper limb relative to trunk length. Unlike relative torso height, the inclusion of the cranium in determining upper body length was not deemed necessary as an alternative to this morphological index (see Chapter 4).
 Reference: Eveleth and Tanner, 1976
- Upper Torso Breadth³: **$(\Sigma \text{ left CML and right CML}) + JNB$**
 (UTB) This index attempts to represent the maximum possible breadth of the torso at its most superior aspect. Weinstein (2002) attempted to examine the same property by clavicular length alone.
 Reference: new morphology (see Holliday, 1995; Weinstein, 2001)
- Lower Body Breadth: **$(BIB \text{ (cm)} \times 1.17) - 3.0$**
 This equation converts skeletal bi-iliac breadth into “living” bi-iliac breadth (i.e., including soft tissue). This is the bi-iliac breadth utilized in determining body mass (see the second equation below), and is directly comparable to anthropometric pelvic breadth measurements.
 References: Ruff, 1991; Ruff et al., 1997
- Body Mass (1)¹: **$(FHD \times 2.268) - 36.5$**
 (BM) Three equations for estimating body mass from femoral head diameters have been developed for humans, though the equation by Grine et al. (1995) has been chosen for use in this dissertation. See Chapter 4 for reasoning and more information on the alternate equations.
 References: Ruff et al., 1991; McHenry, 1992; Grine et al., 1995; Auerbach and Ruff, 2004

Combined cranial and postcranial morphology

- Skeletal Stature:** $\text{BBH} + (\Sigma \text{XC2 through XS1}) + \text{FBL} + \text{TFL} + \text{TCH}$
The “anatomical” revised Fully method for obtaining skeletal stature by adding the superoinferior dimensions of the elements that constitute stature. This is applied to skeletons following the protocol developed by Raxter et al. (2006), using complete skeletons and those with missing elements estimated under the protocol described in Chapter 5.
References: Fully, 1956; Raxter et al., 2006
- Living Stature:** $(1.009 \times \text{Skeletal stature (cm)}) - 0.0426 \times \text{Age (years)} + 12.1$
(STAT)
The equation for converting skeletal stature into living stature (i.e., the soft tissue correction for skeletal stature). As determined by Raxter et al. (2007), the formula that includes age as a variable is favored for this.
References: Raxter et al., 2006; Raxter et al., 2007
- Relative Torso Height (2)^{1,2}:** $[\text{BBH} + (\Sigma \text{XC2 through XS1})] \div (\text{FBL} + \text{TFL} + \text{TCH})$
In an attempt to develop an equation more comparable with relative sitting height in anthropometric studies, this equation uses the full upper body length and lower body lengths. However, unlike the first method adapted from Holliday (1995) (shown above), the number of skeletons to which this method is applied is limited.
Reference: new morphology (but see Holliday, 1995)
- Body Mass (2):** ♂: $(0.422 \times \text{Living stature}) + (3.126 \times \text{Lower body breadth}) - 92.9$
♀: $(0.504 \times \text{Living stature}) + (1.804 \times \text{Lower body breadth}) - 72.6$
An alternative to body mass estimation using femoral head, and therefore freed of possible mechanical biases in determining body mass, this method is also employed on the skeletons with reconstructed anatomical statures and intact bi-iliac breadths. Previous studies (Ruff et al., 1997; Auerbach and Ruff, 2004) have shown a good correspondence between this method and the body masses derived from femoral heads. This method is used in this dissertation primarily as a method for discriminating the best femoral head estimation method for body mass (see Chapter 4).
References: Ruff et al., 1997; Auerbach and Ruff, 2004; Ruff et al., 2005

Robusticity and asymmetry equations

Humeral robusticity (all bilateral measurements are averaged)

Mediolateral
Robusticity: $(\text{HMLD})^3 \div (\text{FHD Body Mass} \times \text{HML}) \times 1000$

Anteroposterior
Robusticity: $(\text{HAPD})^3 \div (\text{FHD Body Mass} \times \text{HML}) \times 1000$

Average Diaphyseal

Robusticity: $[(\text{HMLD} + \text{HAPD}) \div 2]^3 \div (\text{FHD Body Mass} \times \text{HML}) \times 1000$

All of these equations provide a scaled measurement of “strength” in the midshaft diaphyseal breadth of the humerus. Although an *approximation* of the strength of the diaphysis in loading, these values are not true robusticity values.

Reference: Ruff, 2000

Femoral robusticity (all bilateral measurements are averaged)

Mediolateral
Robusticity: $(\text{FMLD})^3 \div (\text{FHD Body Mass} \times \text{FML}) \times 1000$

Anteroposterior
Robusticity: $(\text{FAPD})^3 \div (\text{FHD Body Mass} \times \text{FML}) \times 1000$

Average Diaphyseal

Robusticity: $[(\text{FMLD} + \text{FAPD}) \div 2]^3 \div (\text{FHD Body Mass} \times \text{FML}) \times 1000$

All of these equations provide a scaled measurement of “strength” in the midshaft diaphyseal breadth of the femur. Although an *approximation* of the strength of the diaphysis in loading, these values are not true robusticity values.

Reference: Ruff, 2000

Bilateral asymmetry

(%DA) Percent

Directional: $(\text{Right side measurement} - \text{left side measurement}) \div (\text{Average of right side and left side measurements}) \times 100$

Gives the directional percentage bilateral asymmetry in a given dimension, scaled to the size of the measurement to allow for comparisons among dimensions of different sizes. Positive values designate right-side biased asymmetry in a given dimension; negative values designate left-side bias.

Reference: Auerbach and Ruff, 2006

(%AA) Percent

Absolute:

$$\frac{(\text{Maximum measurement} - \text{minimum measurement})}{(\text{Average of maximum and minimum measurements})} \times 100$$

Gives the total percentage bilateral asymmetry in a given dimension, scaled to the size of the measurement to allow for comparisons among dimensions of different sizes. This percent describes the total amount of bilateral asymmetry, or the “random” asymmetry in a given dimension.

Reference: Auerbach and Ruff, 2006

Ratios of posterior centrum heights to maximum anterior heights of centra—used to convert vertebral measurements from Trenton W. Holliday’s data set (COD) (courtesy of Maijanen and Niskanen, 2006)

Vertebra	Posterior / maximum anterior centrum height	
	Males (<i>n</i> = 27)	Females (<i>n</i> = 32)
T1	0.986	1.001
T2	1.030	1.056
T3	1.036	1.043
T4	1.008	0.991
T5	1.011	0.979
T6	1.000	0.996
T7	0.986	0.976
T8	0.986	0.982
T9	0.993	0.997
T10	0.968	0.969
T11	0.944	0.950
T12	0.928	0.960
L1	0.937	0.961
L2	0.980	0.980
L3	1.022	1.040
L4	1.080	1.086
L5	1.217	1.248

Appendix IV. Climate data for paleoclimate model of POD sites.

Station numbers for locations within the United States are National Weather Service Cooperative Station Network identifications. These station six-digit identification numbers are provided below with climate data. Weather data for Canada, Ecuador, Peru, Chile and Argentina are gathered from world-wide weather station network (which have eleven-digit identification codes). All data are available from the National Oceanic and Atmospheric Administration’s (NOAA) National Climate Data Center (www.ncdc.noaa.gov).

Dates for climatological data are from a station’s first year of complete data collection until 1990, unless otherwise indicated. (This is particularly the case for sites in the U.S. Southwest that use data from the 1950-1956 New Mexico-Arizona-California drought.)

Data collected at Cooperative Stations are recorded in Imperial units (inches, degrees Fahrenheit); data presented in this appendix has been converted to centimeters for precipitation and degrees Celsius. World-wide station data are in SI Units.

Stations are selected based on a climate model created by examining published palaeopaleontological data from the regions in which sites have been located. See Section 4.5 (page 201) for further explanation of the climate modeling process. A number of papers and recent models based on multiple climatic data modeling methods have been used to develop and corroborate these models (e.g., Cole and Liu, 1994; Davis, 1999; Briffa, 2000; Davi et al., 2003; Schimmelmann et al., 2003; Mensing et al., 2004; Booth et al., 2005). In addition, an increasing number of resources are available from NOAA for climatic modeling (www.noaa.gov).

Variables: MXT, mean highest temperature of the warmest month; MNT, mean lowest temperature of the coolest month; MAT, mean annual temperature; MTP, mean total annual precipitation. Note that the “Annual” column reports the unweighted mean temperature and the *total annual* precipitation for each site.

Site: Pre-Aleut
Station: 504988

Variable	January	February	March	April	May	June	July	August	September	October	November	December	Annual
MXT	1.67	2.28	3.83	6.50	9.72	13.11	15.83	16.61	13.67	8.44	4.39	2.44	8.22
MNT	-4.06	-3.94	-2.83	-0.33	3.06	6.44	9.00	9.11	6.33	1.22	-1.78	-3.78	1.56
MAT	-1.17	-0.83	0.50	3.06	6.39	9.78	12.44	12.89	10.00	4.83	1.33	-0.67	4.89
MTP	18.75	13.41	11.76	10.67	14.02	12.14	9.40	13.08	17.75	18.24	15.14	17.30	171.65

Site: Neo-Aleut
Station: 500026

Variable	January	February	March	April	May	June	July	August	September	October	November	December	Annual
MXT	2.72	2.67	3.94	5.39	7.56	9.78	12.39	13.28	11.33	8.56	5.44	3.56	7.22
MNT	-2.11	-2.28	-0.94	0.61	2.61	4.94	7.17	8.17	6.39	3.50	0.67	-0.89	2.33
MAT	0.33	0.22	1.50	3.00	5.11	7.39	9.78	10.72	8.89	6.06	3.11	1.33	4.78
MTP	13.11	9.80	12.01	9.98	7.44	6.20	6.88	10.34	12.60	14.78	18.03	16.94	138.13

Site: Ikogmiut
Station: 500754

Variable	January	February	March	April	May	June	July	August	September	October	November	December	Annual
MXT	-10.61	-10.67	-6.06	-0.39	9.00	14.89	16.83	15.28	11.11	1.67	-5.22	-9.61	2.17
MNT	-17.56	-18.22	-14.78	-9.06	-0.17	5.72	8.72	7.94	3.50	-4.56	-11.72	-16.56	-5.56
MAT	-14.06	-14.44	-10.39	-4.67	4.39	10.28	12.78	11.61	7.33	-1.44	-8.44	-13.06	-1.67
MTP	1.47	1.09	1.50	1.78	1.98	3.66	5.03	7.39	5.18	3.68	2.72	2.59	38.07

Site: Kuskowagamiut
Station: 500754

Variable	January	February	March	April	May	June	July	August	September	October	November	December	Annual
MXT	-10.61	-10.67	-6.06	-0.39	9.00	14.89	16.83	15.28	11.11	1.67	-5.22	-9.61	2.17
MNT	-17.56	-18.22	-14.78	-9.06	-0.17	5.72	8.72	7.94	3.50	-4.56	-11.72	-16.56	-5.56
MAT	-14.06	-14.44	-10.39	-4.67	4.39	10.28	12.78	11.61	7.33	-1.44	-8.44	-13.06	-1.67
MTP	1.47	1.09	1.50	1.78	1.98	3.66	5.03	7.39	5.18	3.68	2.72	2.59	38.07

Site: Point Barrow
Station: 500546

Variable	January	February	March	April	May	June	July	August	September	October	November	December	Annual
MXT	-21.89	-24.33	-22.78	-15.17	-4.33	3.50	7.22	5.72	1.00	-7.72	-15.83	-20.67	-9.61
MNT	-28.50	-30.94	-29.50	-22.83	-9.78	-1.28	0.89	0.72	-2.78	-12.89	-21.61	-27.33	-15.50
MAT	-25.22	-27.67	-26.17	-19.00	-7.06	1.11	4.06	3.28	-0.83	-10.28	-18.72	-24.00	-12.56
MTP	0.43	0.38	0.43	0.51	0.41	0.71	2.39	2.44	1.52	1.14	0.64	0.41	11.40

Sites: Point Hope – Norton, Birmirk, and Ipiutak cultural periods
Station: 506496

Variable	January	February	March	April	May	June	July	August	September	October	November	December	Annual
MXT	-9.61	-11.00	-8.11	-3.61	5.56	11.61	14.28	13.39	9.28	0.94	-5.28	-9.39	0.67
MNT	-18.17	-20.28	-17.94	-12.39	-1.56	3.78	7.33	6.72	2.39	-5.44	-12.61	-18.06	-7.17
MAT	-13.89	-15.61	-13.00	-8.00	2.00	7.72	10.83	10.11	5.83	-2.22	-8.94	-13.72	-3.22
MTP	2.01	1.52	1.37	1.73	1.57	2.84	5.51	6.88	6.17	3.43	2.64	2.11	37.80

Site: Point Hope – Tigara
Station: 509739

Variable	January	February	March	April	May	June	July	August	September	October	November	December	Annual
MXT	-12.17	-16.56	-14.39	-8.89	0.17	6.22	10.83	10.67	6.78	0.28	-5.44	-11.67	-2.83
MNT	-20.11	-24.00	-22.11	-16.33	-5.33	0.67	5.72	6.11	2.67	-4.22	-11.61	-18.94	-8.94
MAT	-16.17	-20.28	-18.22	-12.56	-2.56	3.44	8.28	8.39	4.72	-1.94	-8.50	-15.33	-5.89
MTP	1.24	0.79	0.94	0.86	1.50	2.21	4.17	6.45	5.69	3.63	1.83	1.22	30.53

Site: Canyon del Muerto
 Station: 021248 (1950-1956 data)

Variable	January	February	March	April	May	June	July	August	September	October	November	December	Annual
MXT	8.68	10.32	14.59	20.62	25.72	31.70	33.63	32.04	30.24	23.31	12.24	7.73	20.90
MNT	-6.11	-6.61	-3.40	1.85	6.78	11.35	15.76	14.79	9.93	3.11	-4.92	-7.69	2.90
MAT	1.30	1.87	5.61	11.25	16.27	21.54	24.70	23.44	20.10	13.22	3.68	0.03	11.92
MTP	1.61	0.71	0.90	1.33	1.12	0.79	3.15	3.29	1.94	1.43	1.21	0.73	18.21

Site: Carter Ranch
 Station: 024089 (1950-1956 data)

Variable	January	February	March	April	May	June	July	August	September	October	November	December	Annual
MXT	11.16	11.83	16.66	22.06	26.98	32.92	34.91	33.08	31.63	25.19	14.93	8.44	22.48
MNT	-5.69	-6.74	-3.48	1.77	6.54	10.66	15.81	14.77	10.11	3.71	-4.18	-6.91	3.03
MAT	2.74	2.56	6.60	11.61	16.61	21.81	25.37	23.94	20.88	14.46	5.39	1.24	12.77
MTP	1.24	1.02	0.94	1.61	0.29	1.28	4.33	3.58	2.11	0.53	1.59	0.78	19.30

Site: Grasshopper
 Station: 026653 (1950-1956 data)

Variable	January	February	March	April	May	June	July	August	September	October	November	December	Annual
MXT	12.39	14.33	16.11	20.61	25.28	30.89	32.50	30.83	28.28	23.61	17.22	12.83	22.06
MNT	-6.50	-5.28	-3.56	-1.33	1.89	6.33	12.61	11.94	7.78	1.72	-3.39	-6.39	1.33
MAT	2.94	4.56	6.28	9.61	13.61	18.61	22.61	21.39	18.06	12.72	6.89	3.22	11.72
MTP	5.64	2.49	4.88	3.16	0.82	1.52	11.54	8.51	2.45	1.21	3.56	3.00	48.79

Site: Kinishba

Station: 029271 (1950-1956 data)

Variable	January	February	March	April	May	June	July	August	September	October	November	December	Annual
MXT	12.65	13.16	15.58	20.51	25.28	31.31	32.64	30.68	31.28	25.81	17.49	12.55	22.41
MNT	-5.20	-5.70	-2.28	2.15	5.86	10.78	14.82	13.93	10.61	5.13	-2.39	-5.73	3.50
MAT	3.73	3.75	6.67	11.33	15.58	21.06	23.75	22.31	20.96	15.48	7.57	3.43	12.97
MTP	5.20	1.98	4.45	3.23	0.47	2.26	5.99	11.01	2.32	1.30	2.56	2.82	43.60

Sites: Point of Pines / Turkey Creek

Station: 020808 (1950-1956 data)

Variable	January	February	March	April	May	June	July	August	September	October	November	December	Annual
MXT	10.13	10.41	13.58	19.36	23.89	29.87	30.68	28.62	28.83	23.06	14.92	9.97	20.28
MNT	-5.70	-7.28	-3.77	1.17	5.19	10.08	14.63	13.44	10.73	4.69	-3.09	-6.85	2.77
MAT	2.23	1.59	4.92	10.27	14.56	19.99	22.68	21.04	19.79	13.88	5.93	1.57	11.54
MTP	4.22	2.01	4.90	2.34	0.82	1.61	8.77	8.60	1.85	1.60	1.48	2.67	40.88

Sites: Mississippi River Sites: Pecan Point / St. Francis & Black River Sites

Station: 030806

Variable	January	February	March	April	May	June	July	August	September	October	November	December	Annual
MXT	7.06	9.56	15.56	21.89	27.06	31.72	33.39	32.22	28.50	23.22	15.72	9.44	21.28
MNT	-3.22	-1.00	4.61	10.39	15.39	19.83	21.89	20.56	16.67	10.00	4.72	-0.44	9.94
MAT	1.89	4.28	10.06	16.17	21.22	25.78	27.67	26.39	22.61	16.61	10.22	4.50	15.61
MTP	8.46	10.29	13.11	12.32	13.11	10.54	9.83	7.90	9.73	7.85	12.12	12.24	127.48

Site: Ouachita River Valley Sites: Boytt's Field
 Station: 032540

Variable	January	February	March	April	May	June	July	August	September	October	November	December	Annual
MXT	10.94	13.94	19.00	24.06	27.83	31.33	33.50	33.33	29.56	24.17	17.89	12.44	23.17
MNT	-1.44	0.61	5.50	10.44	14.56	18.67	20.72	19.94	16.78	10.33	4.61	0.28	10.11
MAT	4.78	7.28	12.28	17.28	21.22	25.00	27.11	26.67	23.17	17.28	11.28	6.39	16.67
MTP	10.06	10.92	13.34	11.33	12.70	9.83	11.10	7.72	9.80	10.57	12.80	13.49	133.65

Site: Red River Valley Sites: McClure Place
 Station: 037048

Variable	January	February	March	April	May	June	July	August	September	October	November	December	Annual
MXT	12.17	15.22	20.17	24.94	28.28	31.89	33.89	33.94	30.39	25.50	19.22	13.83	24.11
MNT	1.67	3.89	8.11	12.72	16.89	20.83	22.61	22.06	18.89	12.89	8.06	3.50	12.67
MAT	6.94	9.56	14.17	18.83	22.56	26.39	28.22	28.06	24.67	19.22	13.67	8.67	18.39
MTP	7.98	8.99	10.69	11.00	11.43	11.10	9.58	7.57	8.56	8.64	11.66	11.91	119.10

Sites: Bear Creek / Blossom (Goldman) / Cook / Sacramento River Sites / Jones / Mustang Mound
 Station: 356751

Variable	January	February	March	April	May	June	July	August	September	October	November	December	Annual
MXT	7.44	10.56	13.33	15.89	19.50	23.33	26.61	26.83	23.67	17.78	11.44	7.56	17.00
MNT	0.94	2.28	3.67	5.17	8.33	11.61	13.61	13.83	11.11	7.17	4.17	1.56	6.94
MAT	4.22	6.44	8.50	10.56	13.94	17.50	20.11	20.33	17.39	12.50	7.83	4.56	12.00
MTP	13.59	9.78	9.04	6.07	5.23	3.76	1.60	2.77	4.45	6.78	13.56	15.57	92.20

Site: Channel Islands
 Station: 042516 (temperature data) / 047953 (precipitation data)

Variable	January	February	March	April	May	June	July	August	September	October	November	December	Annual
MXT	17.67	18.72	19.83	22.72	25.83	30.28	34.61	34.78	32.17	27.67	21.72	17.94	25.33
MNT	1.78	2.56	3.11	4.83	7.50	10.00	12.61	12.89	10.89	7.61	4.11	1.72	6.61
MAT	9.72	10.67	11.50	13.78	16.67	20.11	23.67	23.83	21.50	17.67	12.94	9.83	16.00
MTP	6.76	7.52	5.77	2.08	0.36	0.03	0.05	0.43	0.58	0.66	4.60	4.72	33.55

Site: Cuyama Ranch
 Station: 047902

Variable	January	February	March	April	May	June	July	August	September	October	November	December	Annual
MXT	18.33	18.72	19.11	20.33	20.78	22.06	24.06	25.00	24.33	23.44	20.61	18.67	21.28
MNT	6.33	7.44	8.33	9.44	11.00	12.78	14.33	15.11	14.28	12.17	9.17	6.44	10.56
MAT	12.33	13.11	13.72	14.94	15.89	17.44	19.22	20.06	19.33	17.83	14.89	12.56	15.94
MTP	9.07	9.53	6.99	3.23	0.51	0.18	0.03	0.13	0.79	0.84	5.54	6.32	43.13

Sites: Ellis Landing / Point Sal / Ryan Mound
 Station: 047767 (1974-1977 data)

Variable	January	February	March	April	May	June	July	August	September	October	November	December	Annual
MXT	14.54	15.01	14.75	15.46	16.46	17.10	17.69	18.57	18.63	19.03	17.15	14.90	16.61
MNT	5.38	6.47	7.33	7.26	8.99	10.35	11.69	12.60	12.08	10.83	8.31	6.78	9.01
MAT	9.97	10.75	11.06	11.38	12.74	13.74	14.71	15.60	15.36	14.94	12.75	10.85	12.82
MTP	8.53	8.30	9.74	8.37	9.95	10.31	11.06	11.55	11.71	11.41	11.31	10.09	17.04

Site: Karlo
 Station: 048702 (1950-1956 data)

Variable	January	February	March	April	May	June	July	August	September	October	November	December	Annual
MXT	4.07	7.08	10.53	16.79	21.23	25.63	32.02	30.62	27.22	19.44	11.19	4.94	17.56
MNT	-6.44	-6.57	-4.62	-0.67	2.61	5.61	8.75	6.85	4.61	0.09	-3.37	-5.74	0.09
MAT	-1.17	0.26	2.97	8.07	11.94	15.63	20.39	18.75	15.93	9.78	3.92	-0.38	8.84
MTP	16.36	11.84	10.44	4.14	0.97	0.43	0.13	0.28	0.86	4.47	11.99	11.76	73.66

Site: La Jolla
 Station: 412797

Variable	January	February	March	April	May	June	July	August	September	October	November	December	Annual
MXT	13.39	16.78	21.06	25.94	30.61	35.83	35.61	34.17	30.61	25.78	19.11	14.17	25.28
MNT	-1.44	1.06	4.56	8.89	13.61	17.94	20.22	19.22	16.44	9.78	3.56	-0.72	9.44
MAT	6.00	8.94	12.83	17.44	22.11	26.89	27.94	26.72	23.56	17.78	11.33	6.72	17.33
MTP	1.02	1.04	0.74	0.51	0.64	1.70	3.91	4.01	4.32	1.93	1.12	1.45	22.38

Site: Napa Valley
 Station: 422625

Variable	January	February	March	April	May	June	July	August	September	October	November	December	Annual
MXT	2.67	5.06	8.33	13.61	19.44	25.33	30.11	29.00	23.83	16.94	8.28	3.50	15.50
MNT	-9.06	-6.67	-3.78	0.11	3.56	7.89	12.44	11.67	6.83	1.44	-3.22	-7.94	1.11
MAT	-3.17	-0.78	2.28	6.89	11.50	16.67	21.28	20.33	15.33	9.22	2.56	-2.22	8.33
MTP	3.66	3.94	4.67	4.39	4.09	2.97	3.25	3.61	3.18	3.91	3.91	3.56	45.14

Site: Need 1
 Station: 047689

Variable	January	February	March	April	May	June	July	August	September	October	November	December	Annual
MXT	11.83	13.44	14.61	17.61	21.94	26.44	30.72	30.61	27.72	22.89	15.39	11.44	20.39
MNT	1.28	1.72	2.06	4.17	7.72	11.78	15.44	15.17	12.67	8.89	4.11	1.67	7.22
MAT	6.56	7.61	8.33	10.89	14.83	19.11	23.11	22.89	20.22	15.89	9.78	6.56	13.83
MTP	19.69	17.53	17.22	10.08	4.24	1.78	0.69	1.14	3.40	6.83	17.27	16.71	116.59

Site: Tulamnui
 Station: 040442

Variable	January	February	March	April	May	June	July	August	September	October	November	December	Annual
MXT	13.83	17.72	20.50	24.39	29.22	33.56	36.94	35.89	32.28	27.06	19.33	13.61	25.39
MNT	3.67	5.89	7.67	10.06	14.06	17.78	20.89	20.28	17.50	12.67	7.06	3.50	11.78
MAT	8.78	11.83	14.11	17.22	21.67	25.67	28.94	28.11	24.89	19.89	13.22	8.61	18.56
MTP	2.18	2.69	2.64	1.45	0.51	0.25	0.03	0.23	0.43	0.74	1.78	1.60	14.53

Sites: Western Berkeley / Yerba Buena & Bayshore Mound
 Station: 047772

Variable	January	February	March	April	May	June	July	August	September	October	November	December	Annual
MXT	11.81	14.50	15.58	15.49	17.31	16.65	17.01	17.49	19.64	19.63	17.56	13.49	16.34
MNT	6.32	7.82	8.22	8.96	9.90	10.75	11.18	11.14	12.08	11.92	10.61	8.81	9.81
MAT	9.08	11.18	11.92	12.25	13.61	13.71	14.13	14.33	15.88	15.79	14.10	11.17	13.09
MTP	16.86	5.80	5.18	2.75	0.86	0.29	0.02	0.28	0.06	2.31	8.31	21.88	64.60

Site: Yuma III
 Station: 041758

Variable	January	February	March	April	May	June	July	August	September	October	November	December	Annual
MXT	18.44	18.72	18.39	19.33	19.56	20.72	22.83	23.89	24.17	23.00	20.56	18.50	20.67
MNT	7.39	8.33	9.50	11.00	13.33	15.22	17.39	18.33	17.06	13.94	10.06	7.50	12.44
MAT	12.94	13.50	13.94	15.17	16.44	18.00	20.11	21.11	20.67	18.50	15.33	13.00	16.56
MTP	3.94	3.51	4.47	1.96	0.41	0.18	0.05	0.20	0.61	0.89	3.94	3.58	23.72

Site: Ackmen (Lowry Ruin) / Yellow Jacket
 Station: 055531 (1950-1956 data)

Variable	January	February	March	April	May	June	July	August	September	October	November	December	Annual
MXT	5.75	6.98	10.42	16.71	21.73	28.37	30.51	29.25	26.82	20.88	10.92	5.83	17.85
MNT	-5.97	-6.17	-3.98	1.06	5.70	11.12	14.07	13.13	10.60	5.36	-2.68	-6.30	2.99
MAT	-0.10	0.42	3.23	8.90	13.73	19.76	22.30	21.21	18.71	13.14	4.13	-0.23	10.43
MTP	4.86	2.56	2.65	3.06	2.18	1.15	5.33	5.29	2.47	2.54	2.32	3.93	38.35

Sites: Bayshore Mounds / Palmer
 Station: 080945

Variable	January	February	March	April	May	June	July	August	September	October	November	December	Annual
MXT	21.83	22.50	25.00	27.67	30.39	32.00	32.67	32.72	31.78	29.22	25.83	23.00	27.89
MNT	9.44	10.28	13.00	14.89	18.06	21.17	22.17	22.39	21.89	18.06	13.94	10.67	16.33
MAT	15.67	16.39	19.00	21.28	24.28	26.61	27.44	27.61	26.83	23.61	19.89	16.83	22.11
MTP	6.25	7.67	8.15	3.10	7.04	19.86	22.66	24.00	20.19	6.48	5.28	5.74	136.42

Sites: Little Salt Spring / Warm Mineral Springs
 Station: 393294

Variable	January	February	March	April	May	June	July	August	September	October	November	December	Annual
MXT	-5.33	-2.06	4.39	13.33	20.22	25.78	30.28	29.28	22.94	15.78	5.06	-3.06	13.06
MNT	-17.17	-14.11	-7.83	-0.11	6.22	11.83	14.83	13.28	7.33	0.83	-6.83	-14.33	-0.50
MAT	-11.22	-8.06	-1.72	6.61	13.22	18.83	22.56	21.28	15.17	8.33	-0.89	-8.67	6.28
MTP	0.94	1.32	3.18	5.64	7.01	7.29	5.99	5.72	3.25	2.90	1.55	1.45	46.23

Site: Windover Pond
 Station: 044876

Variable	January	February	March	April	May	June	July	August	September	October	November	December	Annual
MXT	6.94	9.17	15.28	20.94	25.33	28.94	30.56	29.83	26.22	20.56	14.61	8.94	19.78
MNT	-5.22	-3.94	0.56	4.94	10.06	14.44	17.00	16.56	12.78	6.11	1.39	-3.00	6.00
MAT	0.89	2.61	7.94	12.94	17.72	21.72	23.78	23.22	19.50	13.39	8.00	2.94	12.89
MTP	6.45	7.16	8.46	7.29	9.27	8.08	9.30	8.05	8.03	9.02	7.67	7.39	96.16

Site: Irene Mound
 Station: 091345

Variable	January	February	March	April	May	June	July	August	September	October	November	December	Annual
MXT	15.39	16.56	20.39	24.22	27.61	30.50	32.06	31.28	29.22	25.17	21.00	17.17	24.22
MNT	5.33	6.61	10.56	14.44	18.83	22.28	23.56	23.44	21.83	16.33	11.22	7.11	15.11
MAT	10.39	11.61	15.50	19.33	23.22	26.39	27.83	27.39	25.50	20.78	16.11	12.17	19.67
MTP	8.48	9.93	9.83	6.38	8.36	12.67	14.27	17.65	16.51	7.47	6.68	7.75	125.98

Site: Albany Mounds
 Station: 131635

Variable	January	February	March	April	May	June	July	August	September	October	November	December	Annual
MXT	-1.50	1.67	8.72	17.11	23.67	28.33	30.06	28.89	24.94	18.39	9.67	1.06	15.94
MNT	-11.50	-8.89	-2.17	4.17	10.17	15.33	17.83	16.44	11.94	5.83	-0.56	-8.06	4.22
MAT	-6.50	-3.61	3.28	10.67	16.94	21.83	23.94	22.67	18.44	12.11	4.56	-3.50	10.06
MTP	4.60	4.40	5.71	9.08	11.43	12.57	9.78	10.33	9.98	5.54	6.54	4.48	94.44

Sites: Calhoun County / Jersey County
 Station: 113940 (1990-2000 data)

Variable	January	February	March	April	May	June	July	August	September	October	November	December	Annual
MXT	0.28	2.94	10.06	17.78	23.61	29.17	31.22	29.78	26.28	19.61	10.89	2.78	17.06
MNT	-10.39	-8.22	-1.61	5.11	10.67	16.22	18.28	16.61	12.22	5.72	-0.28	-6.89	4.78
MAT	-5.06	-2.67	4.22	11.44	17.17	22.72	24.78	23.22	19.22	12.67	5.33	-2.06	10.94
MTP	5.53	5.04	6.52	9.55	13.81	10.22	10.78	8.61	7.87	7.01	7.78	4.87	97.60

Site: Dickson
 Station: 113940

Variable	January	February	March	April	May	June	July	August	September	October	November	December	Annual
MXT	0.28	2.94	10.06	17.78	23.61	29.17	31.22	29.78	26.28	19.61	10.89	2.78	17.06
MNT	-10.39	-8.22	-1.61	5.11	10.67	16.22	18.28	16.61	12.22	5.72	-0.28	-6.89	4.78
MAT	-5.06	-2.67	4.22	11.44	17.17	22.72	24.78	23.22	19.22	12.67	5.33	-2.06	10.94
MTP	4.34	4.34	7.77	8.84	9.83	9.17	10.24	8.61	9.68	7.49	7.32	6.96	94.59

Site: Elizabeth
Station: 114823

Variable	January	February	March	April	May	June	July	August	September	October	November	December	Annual
MXT	-0.17	2.50	9.61	17.28	23.28	28.39	30.72	29.28	25.39	19.11	10.33	2.28	16.50
MNT	-11.78	-9.61	-2.78	4.06	9.83	14.89	17.22	15.72	11.17	4.89	-1.72	-8.28	3.61
MAT	-5.94	-3.56	3.44	10.67	16.56	21.67	24.00	22.50	18.28	12.00	4.33	-3.00	10.06
MTP	3.73	3.30	7.72	9.93	9.86	11.00	10.95	10.01	11.30	7.67	6.96	5.61	98.04

Sites: Fulton County / St. Clair County
Station: 237455 (1990-2000 data)

Variable	January	February	March	April	May	June	July	August	September	October	November	December	Annual
MXT	3.17	5.89	12.56	19.39	24.50	29.56	31.83	30.72	26.61	20.28	12.61	5.39	18.56
MNT	-6.22	-3.83	1.94	8.00	13.33	18.72	21.33	19.94	15.83	9.06	3.17	-3.33	8.17
MAT	-1.50	1.06	7.28	13.72	18.94	24.11	26.56	25.33	21.22	14.67	7.89	1.06	13.39
MTP	7.44	6.12	7.74	12.16	11.03	11.16	9.48	8.29	7.12	5.80	9.16	4.58	100.07

Site: Kuhlman
Station: 118179

Variable	January	February	March	April	May	June	July	August	September	October	November	December	Annual
MXT	0.28	2.89	10.00	17.72	23.72	28.83	30.50	29.00	25.94	19.33	10.94	2.94	16.83
MNT	-8.94	-6.56	-0.22	5.83	11.28	16.61	18.94	17.39	13.28	6.89	1.11	-5.61	5.83
MAT	-4.33	-1.83	4.89	11.78	17.50	22.72	24.72	23.17	19.61	13.11	6.06	-1.28	11.33
MTP	3.84	4.50	8.23	9.35	9.19	8.71	8.94	8.36	8.46	6.60	6.43	6.93	89.54

Site: Modoc Rock Shelter
 Station: 348992

Variable	January	February	March	April	May	June	July	August	September	October	November	December	Annual
MXT	7.44	10.56	16.72	22.78	26.50	30.94	34.28	33.61	28.67	23.22	15.72	9.33	21.67
MNT	-3.94	-1.39	3.94	9.94	14.89	19.83	22.67	21.44	17.22	10.39	4.17	-1.72	9.78
MAT	1.78	4.61	10.33	16.39	20.72	25.39	28.50	27.50	22.94	16.78	9.94	3.83	15.72
MTP	3.25	2.90	6.25	9.27	9.30	11.48	10.46	10.54	9.65	7.32	6.53	5.21	92.15

Site: Wilson
 Station: 112931 (1990-2000 data)

Variable	January	February	March	April	May	June	July	August	September	October	November	December	Annual
MXT	2.67	5.22	11.89	18.44	23.89	29.00	30.72	29.72	26.11	19.94	12.17	5.22	17.94
MNT	-7.11	-5.06	0.94	6.28	11.44	16.17	18.44	17.06	13.28	6.67	1.67	-4.06	6.33
MAT	-2.22	0.11	6.44	12.39	17.67	22.61	24.61	23.39	19.72	13.28	6.94	0.61	12.11
MTP	9.93	5.80	9.71	13.59	11.48	10.86	9.24	7.98	6.44	6.54	10.50	6.30	108.38

Site: Indian Knoll
 Station: 412244

Variable	January	February	March	April	May	June	July	August	September	October	November	December	Annual
MXT	7.44	10.56	16.72	22.78	26.50	30.94	34.28	33.61	28.67	23.22	15.72	9.33	21.67
MNT	-3.94	-1.39	3.94	9.94	14.89	19.83	22.67	21.44	17.22	10.39	4.17	-1.72	9.78
MAT	1.78	4.61	10.33	16.39	20.72	25.39	28.50	27.50	22.94	16.78	9.94	3.83	15.72
MTP	3.25	2.90	6.25	9.27	9.30	11.48	10.46	10.54	9.65	7.32	6.53	5.21	92.15

Site: Glassell Plantation
 Station: 168440

Variable	January	February	March	April	May	June	July	August	September	October	November	December	Annual
MXT	13.00	15.89	20.67	25.06	28.44	32.06	33.89	33.94	30.72	25.94	20.00	14.72	24.56
MNT	1.56	3.33	7.67	12.28	16.67	20.56	22.39	21.83	18.89	12.39	7.39	2.94	12.33
MAT	7.28	9.61	14.17	18.67	22.56	26.33	28.17	27.89	24.83	19.17	13.72	8.89	18.44
MTP	9.86	9.96	9.12	9.53	13.16	10.90	9.32	6.17	7.92	9.47	11.30	10.41	117.12

Sites: Harrelson Landing / Myatts Landing
 Station: 168067

Variable	January	February	March	April	May	June	July	August	September	October	November	December	Annual
MXT	12.28	15.11	19.83	24.67	28.22	31.83	33.67	33.56	30.28	25.28	19.50	14.28	24.06
MNT	0.22	2.17	6.67	11.44	15.67	19.61	21.28	20.72	17.78	10.89	6.33	1.89	11.22
MAT	6.28	8.67	13.28	18.11	21.94	25.72	27.50	27.17	24.06	18.06	12.94	8.11	17.67
MTP	12.34	12.29	13.11	10.54	15.21	9.73	10.36	7.77	9.04	9.58	11.68	14.00	135.66

Site: Jones Landing
 Station: 164696

Variable	January	February	March	April	May	June	July	August	September	October	November	December	Annual
MXT	13.22	15.89	20.56	25.17	28.83	32.28	33.83	33.83	31.17	26.22	20.44	15.28	24.72
MNT	1.22	3.06	7.67	12.28	16.39	20.00	21.50	21.00	18.50	12.06	7.22	3.06	12.00
MAT	7.22	9.50	14.11	18.78	22.61	26.17	27.67	27.44	24.83	19.11	13.83	9.17	18.39
MTP	13.59	13.67	15.01	11.58	14.05	10.46	11.91	8.92	11.00	10.87	14.05	16.84	151.94

Site: Sorrel Bayou
 Station: 160549

Variable	January	February	March	April	May	June	July	August	September	October	November	December	Annual
MXT	15.44	17.56	22.39	26.56	29.83	32.50	33.00	32.83	30.78	26.67	21.61	17.39	25.56
MNT	4.22	5.83	10.11	14.39	18.22	21.33	22.89	22.56	20.44	13.94	9.44	5.83	14.11
MAT	9.89	11.72	16.28	20.50	24.06	26.94	27.94	27.72	25.61	20.33	15.56	11.61	19.83
MTP	12.47	14.02	12.22	13.64	12.42	11.38	17.12	15.24	12.32	8.84	10.95	14.05	154.66

Site: Ward Place
 Station: 160537

Variable	January	February	March	April	May	June	July	August	September	October	November	December	Annual
MXT	12.44	15.28	20.28	25.00	28.94	32.56	34.06	33.94	30.89	25.83	19.56	14.39	24.44
MNT	0.50	2.28	7.39	12.06	16.33	20.28	22.06	21.44	18.28	11.78	6.33	2.28	11.78
MAT	6.50	8.78	13.83	18.56	22.67	26.44	28.06	27.72	24.61	18.83	12.94	8.33	18.11
MTP	12.32	13.00	14.30	11.89	13.69	10.46	9.91	7.82	7.75	9.45	12.62	14.78	138.00

Site: Maine coast
 Station: 170934

Variable	January	February	March	April	May	June	July	August	September	October	November	December	Annual
MXT	-1.06	0.39	5.11	11.33	17.33	22.50	25.50	24.94	20.39	14.67	8.00	1.28	12.56
MNT	-12.00	-10.78	-4.61	1.22	6.56	11.78	15.17	14.44	9.78	4.11	-0.89	-8.33	2.22
MAT	-6.56	-5.17	0.28	6.28	12.00	17.11	20.33	19.72	15.11	9.39	3.56	-3.50	7.39
MTP	8.79	8.97	9.86	10.39	9.42	9.14	7.57	8.36	7.62	9.68	13.16	11.94	114.88

Site: Cape Cod Bay
Station: 193624

Variable	January	February	March	April	May	June	July	August	September	October	November	December	Annual
MXT	2.33	3.33	7.94	13.83	19.78	24.61	27.50	26.28	22.00	16.78	10.94	4.61	15.00
MNT	-7.50	-6.56	-1.89	2.56	7.89	13.00	16.33	15.61	11.17	5.61	1.28	-4.50	4.44
MAT	-2.56	-1.61	3.00	8.17	13.83	18.83	21.94	20.94	16.61	11.22	6.11	0.06	9.72
MTP	10.39	10.29	10.87	10.11	9.75	8.33	8.43	9.96	9.14	10.08	12.27	11.51	121.13

Site: Duck Flat
Station: 269171

Variable	January	February	March	April	May	June	July	August	September	October	November	December	Annual
MXT	5.61	9.44	12.78	17.22	22.78	28.39	33.89	32.56	26.72	20.06	11.28	5.94	18.89
MNT	-8.50	-5.11	-3.78	-1.44	3.17	7.67	10.67	9.28	3.78	-1.50	-4.83	-8.33	0.11
MAT	-1.44	2.17	4.50	7.89	13.00	18.06	22.33	20.94	15.28	9.28	3.22	-1.22	9.50
MTP	1.88	1.57	1.98	2.13	2.11	2.18	0.69	1.14	1.02	1.57	2.39	2.24	20.90

Sites: Fishbone Cave / John Dryden Cave / Lovelock Cave / Winnemucca Lake
Station: 269171 (1975-1990 data)

Variable	January	February	March	April	May	June	July	August	September	October	November	December	Annual
MXT	5.53	9.26	12.98	17.32	22.17	28.18	33.59	32.65	27.12	19.96	11.01	6.10	18.82
MNT	-7.63	-4.76	-2.91	-0.67	3.37	7.35	10.71	9.24	4.55	-1.29	-5.34	-8.51	0.34
MAT	-0.97	2.30	5.06	8.48	12.81	17.83	22.12	21.01	15.79	9.33	2.87	-1.30	9.61
MTP	2.21	1.65	2.21	2.15	2.83	1.80	0.74	0.96	1.41	1.52	2.04	1.91	21.44

Sites: Grimes Point / Spirit Cave
 Station: 263205 (temperature data) / 262780 (precipitation data)

Variable	January	February	March	April	May	June	July	August	September	October	November	December	Annual
MXT	5.67	6.78	8.44	12.06	16.89	22.28	26.50	26.22	22.39	16.67	9.44	5.89	14.94
MNT	-4.44	-3.83	-3.17	-1.56	2.00	6.00	9.28	9.44	6.39	2.44	-1.28	-3.94	1.44
MAT	0.61	1.44	2.67	5.28	9.44	14.17	17.89	17.83	14.39	9.56	4.06	1.00	8.22
MTP	1.22	1.35	1.04	1.40	1.73	1.47	0.53	0.76	0.91	1.09	1.07	0.94	13.51

Site: Brinkerhoff Ranch
 Station: 264698

Variable	January	February	March	April	May	June	July	August	September	October	November	December	Annual
MXT	6.44	11.00	14.67	18.94	24.17	29.17	33.94	32.89	27.83	21.44	12.61	7.06	20.00
MNT	-7.22	-3.94	-1.83	1.11	5.89	10.17	13.39	12.06	7.39	2.00	-2.94	-6.72	2.44
MAT	-0.39	3.56	6.44	10.06	15.06	19.72	23.67	22.44	17.61	11.72	4.83	0.17	11.22
MTP	1.27	1.40	1.17	1.57	1.50	1.35	0.61	0.91	1.07	0.97	1.45	1.55	14.81

Site: Montague
 Station: 288644

Variable	January	February	March	April	May	June	July	August	September	October	November	December	Annual
MXT	0.83	2.44	8.11	14.83	21.11	25.61	28.28	27.28	23.28	17.28	10.61	3.44	15.28
MNT	-11.00	-10.00	-4.17	1.33	6.72	11.89	14.61	13.61	9.11	2.67	-1.39	-7.17	2.17
MAT	-5.06	-3.78	2.00	8.11	13.94	18.78	21.44	20.44	16.22	10.00	4.61	-1.89	8.72
MTP	8.51	7.57	8.92	10.19	11.23	11.28	11.35	10.67	9.65	8.66	10.01	8.94	116.97

Sites: Chaco Canyon / Pueblo Bonito
 Station: 291647 (1950-1956 data)

Variable	January	February	March	April	May	June	July	August	September	October	November	December	Annual
MXT	8.02	9.27	13.35	19.33	24.25	30.83	32.67	31.41	28.54	22.61	12.54	6.55	19.95
MNT	-7.71	-7.77	-5.69	-0.26	3.63	8.67	13.12	11.93	6.97	1.31	-6.83	-10.48	0.57
MAT	0.36	0.99	3.80	9.63	13.96	19.75	22.90	21.69	17.76	11.98	2.87	-1.94	10.31
MTP	0.94	0.78	0.89	1.18	1.27	0.67	2.53	2.30	1.58	0.99	1.18	0.97	15.28

Site: Chamisal
 Station: 290234 (1976-1989 data)

Variable	January	February	March	April	May	June	July	August	September	October	November	December	Annual
MXT	8.43	12.59	16.56	21.83	26.21	32.31	33.98	31.87	28.06	21.59	14.16	9.35	21.41
MNT	-4.86	-2.38	0.34	4.58	9.33	14.93	18.13	17.30	13.12	6.32	-0.36	-4.38	6.01
MAT	1.80	5.12	8.47	13.22	17.79	23.63	26.07	24.60	20.60	13.96	6.92	2.51	13.72
MTP	1.46	1.25	1.30	1.38	1.75	1.70	2.64	4.51	2.37	2.49	1.28	1.18	23.29

Site: Gallina Springs
 Station: 295353 (1976-1989 data)

Variable	January	February	March	April	May	June	July	August	September	October	November	December	Annual
MXT	10.16	12.73	15.40	20.15	24.77	30.20	30.82	28.88	26.27	20.57	14.63	11.48	20.50
MNT	-5.27	-3.44	-1.58	2.30	6.97	11.50	14.35	13.44	10.74	4.03	-1.46	-4.69	3.91
MAT	2.51	4.71	6.92	11.24	15.88	20.86	22.60	21.18	18.51	12.31	6.60	3.42	12.23
MTP	1.93	1.47	1.24	0.79	2.07	2.14	6.85	7.15	5.02	2.82	1.34	1.40	34.22

Site: Hawikuh
Station: 299897

Variable	January	February	March	April	May	June	July	August	September	October	November	December	Annual
MXT	7.78	10.33	13.67	18.89	23.83	29.39	31.17	29.28	26.06	20.83	13.72	8.72	19.50
MNT	-8.94	-6.61	-3.72	-0.61	3.56	8.17	12.56	11.72	7.89	1.72	-3.89	-8.22	1.11
MAT	-0.56	1.89	5.00	9.17	13.72	18.78	21.89	20.50	17.00	11.28	4.94	0.22	10.33
MTP	2.18	1.96	2.62	1.60	1.17	0.89	5.26	5.97	3.66	3.23	2.16	2.46	33.15

Site: Mimbres
Station: 295754 (1976-1989 data)

Variable	January	February	March	April	May	June	July	August	September	October	November	December	Annual
MXT	11.08	13.67	16.21	21.18	25.29	30.88	30.48	28.68	26.68	21.66	15.58	12.25	21.14
MNT	-6.19	-5.25	-3.98	-1.19	2.52	7.33	11.40	11.00	6.87	1.30	-3.93	-6.29	1.13
MAT	2.45	4.22	6.13	10.01	13.91	19.12	20.95	19.86	16.79	11.49	5.84	2.99	11.15
MTP	2.39	1.76	2.10	1.09	2.12	2.25	9.30	9.78	5.55	4.35	3.22	3.25	47.16

Site: Paa-Ko
Station: 290234 (1950-1956 data)

Variable	January	February	March	April	May	June	July	August	September	October	November	December	Annual
MXT	10.07	11.59	15.74	21.71	26.67	32.91	33.61	32.37	29.96	24.00	14.23	9.11	21.83
MNT	-3.02	-2.68	0.73	5.80	10.87	16.62	18.77	17.66	14.29	8.30	-0.35	-3.83	6.93
MAT	3.54	4.47	8.25	13.77	18.78	24.78	26.21	25.02	22.13	16.16	6.96	2.65	14.39
MTP	0.57	0.72	0.69	0.78	0.75	1.09	3.57	2.39	1.52	0.54	0.66	0.41	13.69

Site: Pottery Mound
 Station: 295150 (1976-1989 data)

Variable	January	February	March	April	May	June	July	August	September	October	November	December	Annual
MXT	10.43	14.52	18.41	23.22	26.97	32.31	33.58	32.07	28.96	23.12	16.10	11.32	22.58
MNT	-7.01	-4.39	-1.43	2.52	7.30	11.91	15.54	15.18	10.46	3.46	-2.78	-6.58	3.68
MAT	1.72	5.08	8.50	12.89	17.15	22.12	24.58	23.64	19.73	13.30	6.67	2.38	13.15
MTP	1.28	1.37	1.07	1.18	1.74	1.22	2.74	4.07	3.62	2.60	1.47	1.34	23.71

Site: Puye
 Station: 293031

Variable	January	February	March	April	May	June	July	August	September	October	November	December	Annual
MXT	8.61	11.80	15.32	21.77	26.14	32.48	32.83	31.91	29.43	23.30	15.18	8.46	21.43
MNT	-10.39	-8.75	-5.32	0.29	4.74	9.06	13.11	11.36	6.03	0.59	-7.40	-10.70	0.22
MAT	-0.87	1.53	5.02	11.03	15.44	20.79	22.98	21.66	17.76	11.63	3.97	-1.10	10.82
MTP	1.12	0.62	0.53	1.03	2.54	0.99	4.83	4.41	0.99	0.79	0.99	0.39	19.24

Site: Tijeras
 Station: 290234

Variable	January	February	March	April	May	June	July	August	September	October	November	December	Annual
MXT	8.22	11.94	16.33	21.56	26.50	32.22	33.61	31.67	27.72	21.67	14.06	8.61	21.17
MNT	-5.72	-3.11	0.11	4.22	9.22	14.61	18.00	17.00	12.89	6.11	-0.44	-4.94	5.67
MAT	1.22	4.44	8.28	12.89	17.89	23.44	25.83	24.39	20.33	13.89	6.83	1.83	13.44
MTP	1.12	1.17	1.37	1.32	1.27	1.50	3.48	4.17	2.54	2.26	1.09	1.27	22.56

Site: Fort Ancient (Oregonia)
 Station: 332928

Variable	January	February	March	April	May	June	July	August	September	October	November	December	Annual
MXT	2.06	4.11	10.67	17.00	22.78	27.67	29.72	28.89	25.50	18.89	11.72	4.89	17.00
MNT	-8.06	-6.72	-0.94	4.50	9.78	14.94	17.22	15.78	11.61	4.78	0.61	-4.67	4.89
MAT	-3.00	-1.28	4.89	10.78	16.28	21.33	23.50	22.39	18.56	11.83	6.22	0.11	10.94
MTP	5.94	6.22	9.19	9.50	11.40	8.05	10.13	8.28	7.67	7.21	8.53	7.57	99.72

Site: Libben
 Station: 182282

Variable	January	February	March	April	May	June	July	August	September	October	November	December	Annual
MXT	4.56	6.83	13.22	19.28	24.89	29.00	30.94	30.50	26.56	20.06	13.22	6.72	18.83
MNT	-6.50	-5.33	-0.72	4.72	9.61	14.22	16.94	16.06	12.00	5.22	0.72	-3.83	5.28
MAT	-0.94	0.78	6.22	12.00	17.28	21.67	23.94	23.28	19.28	12.67	7.00	1.44	12.06
MTP	6.05	5.82	7.82	8.10	9.30	8.48	8.56	8.38	7.82	7.04	7.01	6.63	91.01

Site: Madisonville
 Station: 331550

Variable	January	February	March	April	May	June	July	August	September	October	November	December	Annual
MXT	3.22	5.56	12.00	18.33	23.72	28.00	30.06	29.44	25.94	19.67	12.94	6.11	17.94
MNT	-7.22	-6.06	-0.44	4.56	9.83	14.83	17.50	16.56	12.83	6.28	1.50	-3.89	5.50
MAT	-2.00	-0.22	5.83	11.44	16.78	21.44	23.78	23.00	19.39	13.00	7.22	1.11	11.72
MTP	7.54	7.29	11.25	10.31	12.12	9.35	11.48	9.55	8.28	7.98	9.65	8.56	113.36

Site: Turner Mounds
 Station: 180470

Variable	January	February	March	April	May	June	July	August	September	October	November	December	Annual
MXT	5.39	7.06	12.72	18.61	24.28	29.22	31.50	30.44	26.61	20.22	14.00	7.83	19.00
MNT	-2.22	-1.17	3.44	8.61	14.33	19.61	22.22	21.39	17.39	10.78	5.61	0.28	10.00
MAT	1.61	2.94	8.11	13.67	19.33	24.44	26.89	25.94	22.00	15.56	9.78	4.06	14.56
MTP	7.98	8.08	9.22	8.23	10.29	8.41	9.45	10.87	8.89	7.57	9.14	9.53	107.65

Sites: Mobridge / Larson
 Station: 395691

Variable	January	February	March	April	May	June	July	August	September	October	November	December	Annual
MXT	-4.89	-1.33	5.11	13.72	20.56	25.72	29.78	28.67	22.17	15.61	5.28	-2.89	13.11
MNT	-16.44	-13.06	-6.78	0.56	7.28	12.89	16.33	15.00	9.00	2.50	-5.61	-13.50	0.67
MAT	-10.67	-7.17	-0.83	7.17	13.89	19.33	23.06	21.83	15.61	9.06	-0.17	-8.17	6.89
MTP	0.86	1.07	2.90	5.31	6.60	7.75	5.18	4.47	3.61	2.74	1.35	1.19	43.03

Site: Cheyenne River / Sully / Black Widow Ridge
 Station: 396170

Variable	January	February	March	April	May	June	July	August	September	October	November	December	Annual
MXT	-2.72	0.00	5.89	14.50	20.94	27.06	31.83	30.83	24.22	17.11	7.22	-0.44	14.72
MNT	-14.11	-11.67	-5.94	1.28	7.56	13.39	16.78	15.50	9.56	3.28	-4.39	-11.39	1.67
MAT	-8.39	-5.83	0.00	7.89	14.28	20.22	24.33	23.22	16.94	10.22	1.44	-5.89	8.22
MTP	0.51	0.79	1.96	4.34	6.20	6.71	5.21	3.56	3.02	2.13	0.79	0.69	35.89

Site: Averbuch
Station: 406402

Variable	January	February	March	April	May	June	July	August	September	October	November	December	Annual
MXT	7.72	10.44	16.22	21.56	26.00	30.28	31.94	31.33	28.06	22.50	15.78	10.11	21.00
MNT	-3.06	-1.17	3.94	8.61	13.67	18.17	20.50	19.83	16.17	9.06	4.22	-0.61	9.11
MAT	2.33	4.67	10.11	15.11	19.83	24.22	26.28	25.61	22.11	15.78	10.00	4.72	15.06
MTP	9.09	9.68	12.32	11.10	12.40	9.07	10.08	8.79	8.79	6.65	10.46	11.71	120.14

Site: Candy Creek
Station: 090451

Variable	January	February	March	April	May	June	July	August	September	October	November	December	Annual
MXT	10.22	12.78	17.94	22.61	26.44	29.89	31.11	30.61	27.67	22.61	17.44	12.22	21.78
MNT	-0.28	1.39	5.83	10.11	14.83	19.00	20.83	20.56	17.50	11.06	6.00	1.67	10.72
MAT	5.00	7.11	11.94	16.39	20.67	24.44	26.00	25.61	22.61	16.83	11.72	6.94	16.28
MTP	12.07	12.22	14.66	10.82	10.90	9.04	12.73	9.30	8.69	7.75	9.80	11.00	128.96

Sites: Cherry / Ledbetter Landing
Station: 348992

Variable	January	February	March	April	May	June	July	August	September	October	November	December	Annual
MXT	7.44	10.56	16.72	22.78	26.50	30.94	34.28	33.61	28.67	23.22	15.72	9.33	21.67
MNT	-3.94	-1.39	3.94	9.94	14.89	19.83	22.67	21.44	17.22	10.39	4.17	-1.72	9.78
MAT	1.78	4.61	10.33	16.39	20.72	25.39	28.50	27.50	22.94	16.78	9.94	3.83	15.72
MTP	3.91	5.00	8.79	9.45	14.22	11.28	7.85	7.92	11.94	9.30	7.95	5.49	103.10

Site: Ebenezer
 Station: 402360 (temperature data) / 403679 (precipitation data)

Variable	January	February	March	April	May	June	July	August	September	October	November	December	Annual
MXT	8.22	11.33	17.11	22.61	26.44	30.22	31.61	31.11	27.94	22.28	15.83	10.17	21.22
MNT	-2.94	-1.22	3.17	7.28	11.78	16.11	18.33	17.94	14.78	7.89	3.44	-0.83	8.00
MAT	2.67	5.06	10.17	14.94	19.17	23.17	25.00	24.56	21.39	15.11	9.67	4.67	14.61
MTP	8.41	8.53	10.21	8.64	10.06	9.53	12.40	8.89	8.28	6.73	7.75	7.90	107.32

Site: Eva
 Station: 341706

Variable	January	February	March	April	May	June	July	August	September	October	November	December	Annual
MXT	11.00	14.17	19.61	24.83	29.17	33.72	36.78	36.17	31.28	25.61	18.00	12.28	24.39
MNT	-3.61	-1.11	3.67	9.28	14.22	18.94	21.28	20.56	16.83	10.22	3.83	-1.78	9.39
MAT	3.72	6.56	11.61	17.06	21.67	26.33	29.06	28.39	24.06	17.94	10.89	5.28	16.89
MTP	2.44	3.56	5.41	6.43	11.30	8.61	5.38	6.81	9.32	6.91	3.91	3.00	73.08

Sites: Hiwassee / Montgomery / Wilson
 Station: 402360

Variable	January	February	March	April	May	June	July	August	September	October	November	December	Annual
MXT	8.22	11.33	17.11	22.61	26.44	30.22	31.61	31.11	27.94	22.28	15.83	10.17	21.22
MNT	-2.94	-1.22	3.17	7.28	11.78	16.11	18.33	17.94	14.78	7.89	3.44	-0.83	8.00
MAT	2.67	5.06	10.17	14.94	19.17	23.17	25.00	24.56	21.39	15.11	9.67	4.67	14.61
MTP	12.27	12.27	16.15	11.58	13.16	9.22	12.07	10.36	10.49	8.61	12.12	14.40	142.70

Site: Ledford Island
 Station: 401808

Variable	January	February	March	April	May	June	July	August	September	October	November	December	Annual
MXT	8.39	11.39	16.61	21.83	25.72	29.56	31.11	30.72	27.44	22.00	16.11	10.56	20.94
MNT	-3.44	-1.72	2.61	6.72	11.44	16.06	18.39	18.00	14.44	7.00	2.39	-1.39	7.56
MAT	2.50	4.83	9.61	14.28	18.56	22.83	24.78	24.39	20.94	14.50	9.28	4.56	14.28
MTP	12.34	11.94	15.24	11.13	12.42	10.29	12.32	8.89	10.57	8.81	11.40	13.46	138.81

Sites: Robinson / Thompson Village
 Station: 153295

Variable	January	February	March	April	May	June	July	August	September	October	November	December	Annual
MXT	6.06	8.44	14.67	20.89	25.22	29.61	31.72	30.94	27.56	21.67	15.00	8.67	20.06
MNT	-4.89	-2.67	2.89	8.06	12.89	17.39	19.50	18.50	15.11	8.00	3.28	-2.06	8.00
MAT	0.61	2.89	8.78	14.50	19.11	23.50	25.61	24.72	21.39	14.83	9.17	3.33	14.06
MTP	8.89	10.74	12.27	12.14	12.19	9.35	10.44	9.25	9.50	8.26	12.01	12.60	127.64

Site: Toqua
 Station: 405158

Variable	January	February	March	April	May	June	July	August	September	October	November	December	Annual
MXT	7.67	10.22	16.00	21.39	25.50	29.39	31.00	30.72	27.61	21.94	15.83	10.00	20.61
MNT	-3.89	-2.67	2.11	6.72	11.67	16.50	18.72	18.28	14.61	7.11	2.56	-1.83	7.50
MAT	1.94	3.83	9.06	14.06	18.61	22.94	24.89	24.50	21.17	14.56	9.22	4.11	14.06
MTP	11.99	11.58	14.88	10.67	11.89	10.26	12.90	9.86	8.38	8.10	10.64	12.93	134.09

Sites: Caplen / Mitchell Ridge
 Station: 413430

Variable	January	February	March	April	May	June	July	August	September	October	November	December	Annual
MXT	14.61	15.83	19.28	23.06	26.56	29.44	30.72	30.94	29.17	25.28	20.72	16.61	23.50
MNT	8.39	9.94	13.72	18.33	22.11	25.11	26.22	26.22	24.11	20.00	15.00	10.50	18.33
MAT	11.50	12.89	16.50	20.72	24.33	27.28	28.50	28.61	26.67	22.67	17.89	13.56	20.94
MTP	8.28	5.74	5.66	6.17	9.12	11.28	10.06	11.35	15.06	7.21	8.56	8.89	107.39

Site: Ernest Whitte
 Station: 414307 (1950-1970 data)

Variable	January	February	March	April	May	June	July	August	September	October	November	December	Annual
MXT	17.27	18.76	22.15	26.01	29.46	32.52	33.84	33.67	31.46	27.63	22.16	18.78	26.14
MNT	6.67	8.01	11.01	15.82	19.35	22.37	23.66	23.43	21.58	16.22	10.74	7.84	15.56
MAT	11.98	13.40	16.60	20.93	24.42	27.46	28.76	28.56	26.54	21.94	16.46	13.32	20.86
MTP	8.40	9.66	5.93	9.92	11.59	12.25	10.35	9.67	12.25	11.25	8.77	9.99	120.03

Site: Fate Bell Shelter
 Station: 412360 (1950-1970 data)

Variable	January	February	March	April	May	June	July	August	September	October	November	December	Annual
MXT	17.66	19.56	24.02	28.92	31.32	34.98	36.88	36.37	32.89	27.84	22.15	17.83	27.75
MNT	4.66	6.49	10.26	15.79	18.90	22.50	23.81	23.56	20.50	14.59	8.93	4.57	14.79
MAT	11.18	13.04	17.15	22.37	25.13	28.76	30.36	29.98	26.71	21.23	15.56	11.22	21.28
MTP	1.06	2.05	1.56	5.57	6.27	3.17	1.38	2.92	9.62	5.16	2.06	1.05	40.37

Site: Loeve Fox
 Station: 418861 (1930-1960 data)

Variable	January	February	March	April	May	June	July	August	September	October	November	December	Annual
MXT	15.95	17.87	21.98	26.35	29.99	33.93	35.88	36.48	33.18	28.69	21.21	17.19	26.53
MNT	3.35	4.95	7.89	12.88	17.44	21.15	22.50	22.24	19.15	13.87	7.29	4.23	13.05
MAT	9.66	11.42	14.93	19.62	23.72	27.55	29.20	29.37	26.17	21.29	14.26	10.72	19.80
MTP	6.59	7.02	5.70	8.33	9.37	9.02	4.63	5.85	8.59	7.02	6.59	7.44	84.38

Site: Black Rock
 Station: 103297

Variable	January	February	March	April	May	June	July	August	September	October	November	December	Annual
MXT	-0.22	3.78	8.50	14.33	19.72	25.22	30.11	29.17	23.61	16.94	7.33	0.78	14.94
MNT	-11.22	-8.00	-4.44	-0.44	4.06	8.33	11.28	9.94	5.11	-0.44	-4.56	-10.00	-0.06
MAT	-5.72	-2.06	2.06	6.94	11.94	16.78	20.72	19.56	14.39	8.28	1.39	-4.61	7.50
MTP	2.16	2.24	2.79	2.74	3.84	2.84	1.80	2.13	2.26	2.62	2.72	2.36	30.51

Site: Caldwell Village
 Station: 484065

Variable	January	February	March	April	May	June	July	August	September	October	November	December	Annual
MXT	-0.61	2.17	6.67	12.44	18.83	24.78	29.67	28.44	22.67	16.44	6.67	0.56	14.06
MNT	-16.72	-14.28	-8.56	-3.50	1.56	5.94	9.33	7.83	1.89	-3.89	-9.89	-15.61	-3.83
MAT	-8.67	-6.06	-0.89	4.50	10.22	15.33	19.50	18.17	12.33	6.28	-1.61	-7.50	5.11
MTP	1.7526	2.1844	2.794	2.667	2.9718	2.2606	3.3274	3.556	3.7338	3.175	2.1082	1.8542	32.385

Site: Coombs
 Station: 421006 (1950-1956 data)

Variable	January	February	March	April	May	June	July	August	September	October	November	December	Annual
MXT	2.79	4.15	6.85	13.10	17.86	24.24	27.13	25.40	23.13	16.75	8.29	3.96	14.47
MNT	-13.83	-13.54	-9.75	-5.10	-1.68	2.02	7.15	5.72	1.78	-3.18	-9.11	-12.56	-4.34
MAT	-5.52	-4.68	-1.44	4.01	8.10	13.14	17.15	15.57	12.47	6.79	-0.40	-4.28	5.08
MTP	3.74	1.45	2.89	1.97	1.73	1.16	3.85	4.80	3.48	2.44	2.38	2.43	32.33

Site: Duna Leyenda
 Station: 425582 (temperature data) / 029156 (precipitation data)

Variable	January	February	March	April	May	June	July	August	September	October	November	December	Annual
MXT	6.06	11.17	16.11	21.39	27.22	33.61	36.56	34.89	30.17	23.11	14.44	7.33	21.83
MNT	-7.78	-4.33	-0.89	3.22	8.67	13.72	18.22	16.94	11.33	4.17	-1.78	-6.89	4.56
MAT	-0.83	3.44	7.61	12.33	17.94	23.67	27.39	25.94	20.78	13.67	6.33	0.22	13.22
MTP	3.94	3.78	5.03	2.51	1.63	1.07	5.97	6.48	4.57	3.53	3.73	4.98	47.22

Site: Evans / Median Village / Paragonah
 Station: 426686 (1950-1956 data)

Variable	January	February	March	April	May	June	July	August	September	October	November	December	Annual
MXT	7.02	8.17	11.79	12.40	21.22	27.01	30.36	29.09	27.06	21.52	13.07	7.76	18.04
MNT	-7.23	-7.13	-3.94	-1.36	5.02	9.13	13.74	12.33	8.41	2.67	-3.69	-6.88	1.75
MAT	-0.10	0.52	3.94	5.53	13.14	18.08	22.06	20.71	17.75	12.12	4.71	0.45	9.91
MTP	2.25	1.85	1.99	2.74	2.89	1.02	4.42	3.73	1.40	1.42	1.80	2.28	27.80

Site: Ferron Creek
Station: 422798

Variable	January	February	March	April	May	June	July	August	September	October	November	December	Annual
MXT	2.07	2.73	9.21	16.67	20.92	26.35	30.35	28.54	26.54	20.21	9.72	2.82	17.22
MNT	-11.46	-10.69	-5.11	0.95	5.71	10.63	14.73	12.71	8.95	2.37	-5.62	-9.76	1.90
MAT	-4.69	-3.97	2.06	8.83	13.33	18.51	22.55	20.63	17.76	11.30	2.07	-3.45	9.57
MTP	1.85	0.66	1.16	0.69	1.73	0.91	2.08	3.55	1.54	1.03	1.33	1.45	17.46

Site: Glen Canyon
Station: 029114 (temperature data) / 029156 (precipitation data)

Variable	January	February	March	April	May	June	July	August	September	October	November	December	Annual
MXT	7.83	12.11	17.00	22.61	28.17	34.22	36.72	35.17	30.72	23.33	14.67	8.39	22.56
MNT	-3.44	-0.11	3.00	6.94	12.44	17.67	21.44	20.50	15.72	9.50	2.83	-2.50	8.67
MAT	2.17	6.00	10.06	14.83	20.33	25.94	29.11	27.83	23.22	16.44	8.78	3.00	15.67
MTP	4.22	2.38	4.36	2.82	1.04	2.18	7.10	5.80	2.80	1.42	3.04	3.82	40.97

Site: Injun Creek
Station: 426404

Variable	January	February	March	April	May	June	July	August	September	October	November	December	Annual
MXT	3.28	6.94	11.83	17.39	22.72	28.61	33.50	32.33	26.56	19.61	10.67	4.00	18.11
MNT	-6.78	-4.17	-0.33	3.78	8.39	13.17	17.39	16.28	10.94	5.22	-0.39	-5.56	4.83
MAT	-1.72	1.39	5.78	10.56	15.56	20.89	25.44	24.33	18.78	12.44	5.17	-0.78	11.50
MTP	5.05	4.88	5.89	6.55	6.38	3.96	2.06	2.57	4.39	4.90	5.33	5.41	57.38

Site: Polley-Secret Site
 Station: 425733 (1950-1956 data)

Variable	January	February	March	April	May	June	July	August	September	October	November	December	Annual
MXT	8.06	11.36	15.88	23.35	27.92	34.31	38.13	36.08	32.95	26.27	13.81	7.36	23.56
MNT	-6.09	-4.44	-0.69	5.31	8.78	13.40	17.53	15.82	10.75	4.46	-2.92	-6.31	5.11
MAT	1.00	3.47	7.61	14.34	18.36	23.88	27.84	25.96	21.87	15.39	5.45	0.54	14.35
MTP	1.55	0.79	1.34	2.21	1.23	0.26	0.79	1.83	1.64	1.56	1.75	1.36	14.80

Site: Kennewick
 Station: 454154

Variable	January	February	March	April	May	June	July	August	September	October	November	December	Annual
MXT	4.44	9.06	14.56	19.17	23.94	28.61	32.39	31.56	26.00	18.78	10.06	4.72	18.61
MNT	-3.28	-1.00	1.72	4.94	8.61	12.56	15.06	14.78	10.06	4.72	1.28	-2.56	5.56
MAT	0.61	4.06	8.17	12.06	16.28	20.56	23.72	23.17	18.06	11.78	5.67	1.11	12.11
MTP	2.62	1.78	1.73	1.17	1.50	0.97	0.41	0.97	0.91	1.35	2.72	2.92	19.02

Sites: Baldwin / Boardwalk / Dodge Island / Garden Island / Lachane
 Station: 40371897003

Variable	January	February	March	April	May	June	July	August	September	October	November	December	Annual
MXT	4.76	6.46	7.77	10.06	12.77	15.15	17.05	17.44	15.71	11.69	7.37	5.26	10.96
MNT	0.06	1.30	1.13	2.67	4.64	7.44	9.33	9.78	8.13	5.71	2.52	0.67	4.45
MAT	2.41	3.88	4.45	6.37	8.70	11.29	13.19	13.61	11.92	8.70	4.94	2.96	7.70
MTP	36.17	30.00	28.75	25.94	19.39	13.87	12.29	16.11	25.82	40.71	41.80	36.15	327.00

Sites: Fort Rupert / Nimpkish
 Station: 40371894000

Variable	January	February	March	April	May	June	July	August	September	October	November	December	Annual
MXT	7.32	8.23	9.01	10.72	13.05	14.94	16.47	16.93	15.90	13.03	9.95	8.09	11.97
MNT	2.16	2.51	2.79	4.44	6.92	9.41	10.81	11.23	9.79	7.33	4.56	2.98	6.24
MAT	4.74	5.37	5.90	7.58	9.98	12.18	13.64	14.08	12.84	10.18	7.25	5.54	9.11
MTP	38.21	31.94	30.18	22.78	14.26	11.40	8.39	8.90	15.71	34.23	40.68	42.08	298.76

Sites: Hammond / Nanaimo / North Sannich
 Station: 40371892001

Variable	January	February	March	April	May	June	July	August	September	October	November	December	Annual
MXT	5.48	7.64	9.78	12.96	16.62	19.41	21.98	21.66	18.52	13.65	9.04	6.45	13.60
MNT	-0.07	1.12	2.44	4.88	7.96	10.86	12.67	12.63	10.00	6.43	2.86	1.01	6.07
MAT	2.71	4.38	6.11	8.92	12.29	15.14	17.32	17.15	14.26	10.04	5.95	3.73	9.83
MTP	16.66	12.68	10.93	5.97	4.43	3.99	2.43	2.98	4.23	9.94	18.01	19.09	111.32

Site: Kamloops
 Station: 40371897000

Variable	January	February	March	April	May	June	July	August	September	October	November	December	Annual
MXT	-1.64	3.11	9.54	16.14	21.38	25.18	28.60	27.59	21.78	13.92	5.21	0.32	14.26
MNT	-8.86	-5.26	-1.71	2.23	6.84	10.94	12.92	12.31	7.91	2.95	-2.10	-6.26	2.66
MAT	-5.25	-1.07	3.92	9.18	14.11	18.06	20.76	19.95	14.84	8.44	1.55	-2.97	8.46
MTP	2.84	1.57	0.95	1.27	2.02	3.13	2.61	2.82	2.52	1.46	2.11	3.05	26.34

Site: Lillooet Valley
 Station: 40371891001

Variable	January	February	March	April	May	June	July	August	September	October	November	December	Annual
MXT	3.98	6.87	10.43	14.53	18.73	21.63	24.57	24.15	20.18	14.79	8.99	5.20	14.50
MNT	-2.28	-0.80	1.56	4.34	7.65	10.87	12.85	12.59	9.55	5.46	1.64	-0.86	5.21
MAT	0.85	3.03	6.00	9.43	13.19	16.25	18.71	18.37	14.87	10.12	5.32	2.17	9.86
MTP	4.11	2.55	1.66	1.33	1.89	2.67	2.35	2.69	3.03	3.25	3.36	4.96	33.84

Site: Antler Plain / Snowflake / Stott Mound
 Station: 323621

Variable	January	February	March	April	May	June	July	August	September	October	November	December	Annual
MXT	-10.00	-6.44	0.89	11.89	20.89	25.61	28.22	27.39	21.00	13.72	2.06	-7.00	10.67
MNT	-19.72	-16.56	-8.56	0.11	6.61	12.11	14.78	13.28	7.78	2.06	-6.67	-16.11	-0.89
MAT	-14.89	-11.44	-3.83	6.00	13.78	18.89	21.50	20.33	14.39	7.89	-2.28	-11.56	4.89
MTP	1.88	1.22	2.44	3.84	5.21	8.00	7.21	6.50	5.94	3.35	1.73	1.50	48.82

Site: Fort Prince of Wales
 Station: 40371913000

Variable	January	February	March	April	May	June	July	August	September	October	November	December	Annual
MXT	-23.21	-21.71	-15.48	-5.68	2.05	10.54	16.92	15.64	8.68	1.54	-8.56	-18.12	-3.12
MNT	-31.19	-29.53	-22.87	-12.60	-3.02	3.41	8.15	7.27	2.14	-3.93	-15.68	-26.49	-10.36
MAT	-27.20	-25.62	-19.17	-9.14	-0.48	6.97	12.53	11.46	5.41	-1.20	-12.12	-22.31	-6.74
MTP	1.57	1.34	1.75	2.38	3.09	4.36	5.07	6.07	5.30	4.23	3.62	2.06	40.84

Site: Chesterfield Inlet
 Station: 40371083001

Variable	January	February	March	April	May	June	July	August	September	October	November	December	Annual
MXT	-27.93	-28.21	-22.04	-11.98	-2.58	5.83	13.17	11.83	4.98	-2.89	-13.74	-22.48	-8.00
MNT	-35.32	-35.35	-30.42	-21.17	-9.69	-0.39	4.60	4.98	0.19	-8.55	-21.64	-30.25	-15.25
MAT	-31.63	-31.78	-26.23	-16.58	-6.14	2.72	8.88	8.40	2.59	-5.72	-17.69	-26.37	-11.63
MTP	0.83	0.68	0.99	1.42	1.53	2.36	4.36	4.06	3.90	3.43	2.13	1.27	26.97

Site: MacKenzie
 Station: 40371938000

Variable	January	February	March	April	May	June	July	August	September	October	November	December	Annual
MXT	-23.69	-22.76	-22.32	-13.07	-2.15	8.30	14.52	12.73	5.86	-4.15	-16.75	-21.29	-7.06
MNT	-32.03	-31.53	-31.52	-22.93	-10.28	0.15	5.16	4.23	-0.41	-10.54	-24.63	-29.58	-15.33
MAT	-27.86	-27.14	-26.92	-18.00	-6.22	4.23	9.84	8.48	2.73	-7.35	-20.69	-25.44	-11.20
MTP	1.22	1.00	0.97	1.90	1.95	1.48	3.55	4.78	3.88	3.31	1.35	1.02	26.41

Site: Sadlermiut
 Station: 40371915000

Variable	January	February	March	April	May	June	July	August	September	October	November	December	Annual
MXT	-26.01	-25.27	-20.34	-11.15	-2.49	5.57	13.18	11.34	3.88	-4.14	-12.92	-21.18	-7.46
MNT	-34.16	-33.77	-30.21	-21.98	-10.91	-1.15	4.20	3.25	-2.01	-11.16	-21.52	-29.36	-15.73
MAT	-30.09	-29.52	-25.28	-16.57	-6.70	2.21	8.69	7.30	0.94	-7.65	-17.22	-25.27	-11.60
MTP	0.77	0.88	1.08	1.44	1.66	2.79	4.00	4.73	3.52	3.48	1.87	1.16	27.37

Site: Ayalán
 Station: 30684203000

Variable	January	February	March	April	May	June	July	August	September	October	November	December	Annual
MXT	31.00	31.00	31.00	32.00	31.00	31.00	29.00	30.00	31.00	30.00	31.00	31.00	30.75
MNT	21.00	22.00	22.00	22.00	20.00	20.00	19.00	18.00	19.00	20.00	20.00	21.00	20.33
MAT	26.15	26.27	26.57	26.69	25.97	24.78	23.98	23.93	24.25	24.39	24.83	25.91	25.31
MTP	23.24	28.63	29.51	17.93	5.53	0.43	0.03	0.04	0.08	0.23	0.16	3.01	108.82

Sites: Ancón / Aramburú / Cerro Azul / Cerro del Oro
 Station: 30984628000

Variable	January	February	March	April	May	June	July	August	September	October	November	December	Annual
MXT	26.30	27.60	27.10	25.90	24.30	21.70	20.90	21.40	21.40	22.20	23.40	24.90	23.93
MNT	17.10	17.70	17.30	16.40	15.10	12.70	12.10	13.20	13.40	13.10	14.90	16.20	14.93
MAT	21.72	22.70	22.23	20.49	18.42	16.84	16.26	16.05	16.43	17.40	18.46	20.27	18.94
MTP	1.20	0.90	0.70	0.40	0.60	1.80	4.40	3.10	3.30	1.70	0.50	0.70	19.70

Site: Nasca sites
 Station: Nasca desert station (no number)

Variable	January	February	March	April	May	June	July	August	September	October	November	December	Annual
MXT	30.40	30.90	31.10	29.60	27.80	25.70	25.10	25.20	27.60	29.10	29.20	33.80	28.79
MNT	18.40	18.90	19.30	16.50	12.40	9.40	8.80	10.20	12.30	13.20	15.10	18.40	14.41
MAT	26.00	26.70	26.80	24.90	22.00	19.10	18.10	19.50	21.90	23.50	24.20	27.70	23.37
MTP	0.14	0.04	0.04	0.06	0.08	0.21	0.23	0.32	0.17	0.11	0.12	0.05	1.57

Appendix V. Part A. Osteometric measurement descriptive statistics, by sample and sex.
(See Appendix II for measurement abbreviations and definitions. All measurements in mm.)

PRE-ALEUT

Dimension	MALES						FEMALES					
	Mean		n	Std. Dev.		Mean		n	Std. Dev.			
	left	right		left	right	left	right		left	right		
BBH	132.27		11	5.61		127.64		14	5.99			
GBL	182.83		12	4.99		177.46		13	6.62			
EUB	143.17		12	4.82		141.23		13	5.23			
UFH	86.07		11	5.57		80.93		14	5.26			
NAH	27.76		12	2.23		27.46		13	2.24			
NAW	24.96		12	1.55		24.80		13	1.34			
ZYG	143.30		10	3.16		134.08		13	5.38			
JNB	27.88		10	2.60		25.40		12	1.35			
CML	156.72	154.10	9	10	5.44	6.92	139.30	138.75	15	12	10.39	9.98
CAPD	11.58	12.29	9	10	1.25	0.73	9.90	10.29	15	12	1.04	1.20
CSID	10.60	10.15	9	10	1.53	1.20	8.90	9.27	15	12	0.90	1.42
C1	11.80		10	1.31		10.86		12	0.74			
XC2	38.46		10	2.08		35.73		12	2.03			
XC3	12.96		10	1.38		12.06		11	1.14			
XC4	12.23		10	1.02		11.71		9	1.21			
XC5	12.01		10	1.03		11.51		11	1.27			
XC6	12.24		11	0.98		11.84		14	1.37			
XC7	14.04		8	0.62		13.59		14	1.29			
XT1	16.11		9	0.41		15.31		14	1.04			
XT2	17.80		11	1.16		17.11		14	1.21			
XT3	18.03		11	0.79		17.00		14	1.24			
XT4	18.25		10	0.74		17.47		14	1.20			
XT5	19.29		10	0.92		18.08		13	1.19			
XT6	19.40		11	0.94		18.89		14	1.36			
XT7	19.92		11	0.94		20.52		14	4.36			
XT8	19.66		12	1.19		19.62		13	1.15			
XT9	20.41		12	1.52		20.11		14	1.39			
XT10	21.16		12	1.29		20.85		14	1.07			
XT11	21.94		12	1.48		21.71		14	0.87			
XT12	23.94		12	1.67		23.69		14	1.06			
XL1	25.05		12	1.27		24.70		15	1.61			
XL2	25.79		13	1.22		24.87		14	2.08			
XL3	26.31		13	1.71		26.02		14	1.94			
XL4	27.20		12	1.47		26.20		14	1.63			

PRE-ALEUT, CONTINUED

Dimension	MALES						FEMALES					
	Mean		n		Std. Dev.		Mean		n		Std. Dev.	
	left	right			left	right	left	right			left	right
XL5	27.00		12		1.42		27.26		14		2.47	
S1	30.15		11		2.49		30.49		14		2.14	
SML	111.40		12		7.18		106.35		13		12.55	
HML	304.92	311.77	12	11	21.12	18.20	279.08	284.89	13	13	10.23	10.12
HEB	63.04	64.05	12	11	2.31	1.57	55.82	57.23	14	13	2.95	2.71
HHD	46.45	47.09	12	11	1.88	2.23	40.96	40.67	13	13	2.18	1.16
HMLD	24.79	25.18	12	11	1.43	2.13	20.96	21.08	13	13	1.53	1.57
HAPD	21.58	22.97	12	11	1.88	1.35	19.23	20.09	13	13	1.37	1.42
HAB	43.99	44.67	12	11	2.03	1.85	39.76	40.11	14	13	1.58	1.43
RML	234.46	236.80	11	10	10.49	8.40	210.19	210.60	13	15	9.61	10.15
RMLD	15.79	16.74	11	10	1.22	1.69	14.46	14.52	13	15	1.73	1.31
RAPD	12.15	12.39	11	10	0.67	0.68	10.43	10.35	13	15	0.78	0.67
RMLH	21.78	22.59	13	10	1.09	1.32	19.98	20.26	13	16	0.89	1.12
RAPH	22.96	23.37	13	10	1.19	1.30	20.84	21.01	13	16	0.99	0.96
RAB	26.99	27.21	12	11	1.35	1.36	24.42	25.17	14	16	1.15	1.42
UML	255.77	254.72	11	9	10.46	8.34	230.19	229.32	8	14	10.39	10.34
UMLD	13.54	13.66	11	10	0.98	0.87	11.68	11.81	8	14	0.61	0.91
UAPD	17.11	17.26	11	10	0.83	1.47	14.06	15.04	8	14	0.89	1.59
FML	421.21	422.58	12	12	23.05	22.14	388.87	387.43	15	14	10.21	10.06
FBL	419.42	420.71	12	12	22.60	21.34	387.40	385.61	15	14	10.51	10.54
FEB	81.68	81.85	11	13	2.83	3.57	74.35	74.46	13	13	4.09	3.73
FAB	72.04	72.61	11	13	2.88	3.52	64.82	64.39	14	13	3.63	3.25
FHD	45.76	46.26	12	12	1.52	1.57	41.56	41.67	15	14	1.85	1.57
FMLD	27.86	28.23	12	12	1.56	1.37	26.21	25.95	15	14	2.09	2.26
FAPD	29.34	29.98	12	12	2.15	2.52	26.05	26.23	15	14	1.35	1.76
TML	342.75	343.00	12	11	18.03	11.91	317.57	317.04	14	13	9.60	10.13
TFL	338.25	338.64	12	11	19.30	12.56	313.70	313.45	14	13	9.22	10.21
TPB	76.17	75.90	12	10	2.78	3.40	70.45	69.55	11	11	3.81	3.54
TPAB	74.36	74.44	12	10	3.20	3.76	68.12	67.84	11	11	4.19	3.89
TMLD	22.47	23.05	11	10	1.60	0.96	19.87	20.73	14	12	1.08	1.34
TAPD	29.68	29.41	11	10	1.48	1.03	25.82	25.29	14	12	1.59	1.35
FIML	326.89	326.21	9	7	16.41	11.04	306.94	311.72	9	9	20.35	7.72
BIB	276.88		12		10.13		270.85		13		15.77	
IBL	156.73	159.25	11	12	8.81	8.64	152.46	151.00	11	9	7.12	5.57
ACH	50.80	50.98	11	13	1.73	1.39	46.59	46.34	16	11	1.59	1.74
TCH	67.44	67.30	8	10	3.11	2.08	61.30	61.61	10	9	3.16	2.51
TTB	30.41	30.53	9	10	1.27	1.61	27.89	28.04	9	9	1.44	1.19

NEO-ALEUT

Dimension	MALES						FEMALES					
	Mean		<i>n</i>	Std. Dev.		Mean		<i>n</i>	Std. Dev.			
	left	right		left	right	left	right		left	right		
BBH	129.04		27	4.97		124.68		19	3.56			
GBL	178.52		27	4.38		174.90		19	6.48			
EUB	147.19		26	5.23		145.26		19	7.62			
UFH	85.90		26	3.99		83.15		19	4.38			
NAH	28.90		26	2.94		27.37		19	2.42			
NAW	24.58		27	1.44		24.28		19	1.96			
ZYG	142.78		27	5.18		135.42		19	4.91			
JNB	27.70		26	2.81		25.53		18	2.85			
CML	151.85	149.04	31	28	8.79	9.30	141.25	140.16	18	19	7.98	9.92
CAPD	11.16	11.49	31	28	1.15	1.21	9.76	10.29	18	19	1.11	1.47
CSID	9.80	10.17	31	28	1.27	1.16	9.00	9.10	18	19	0.72	0.88
C1	11.33		24	1.23		10.73		19	1.33			
XC2	39.64		25	4.70		35.78		21	1.71			
XC3	13.26		23	1.02		12.98		21	3.09			
XC4	13.03		24	0.82		11.83		19	1.01			
XC5	12.58		25	1.10		11.51		20	0.88			
XC6	12.59		26	0.90		11.81		20	0.85			
XC7	14.52		26	1.09		13.84		20	1.12			
XT1	16.64		28	1.21		15.67		20	1.28			
XT2	18.38		29	1.14		17.45		20	1.17			
XT3	18.31		27	0.88		17.35		20	0.92			
XT4	18.62		29	1.15		17.61		20	1.07			
XT5	19.03		29	1.19		18.13		20	1.12			
XT6	19.68		29	1.19		18.59		20	1.28			
XT7	20.16		29	1.32		18.83		19	1.20			
XT8	20.58		29	1.08		19.19		19	0.99			
XT9	21.21		29	1.20		19.85		19	1.30			
XT10	21.43		28	1.13		20.33		21	1.26			
XT11	21.87		30	1.44		20.94		21	1.39			
XT12	23.73		30	1.67		23.49		20	1.62			
XL1	24.85		30	1.36		25.20		20	1.42			
XL2	25.13		31	1.60		26.27		20	1.56			
XL3	25.63		30	1.91		26.56		21	1.67			
XL4	26.53		29	2.05		26.60		22	1.92			

NEO-ALEUT, CONTINUED

Dimension	MALES						FEMALES					
	Mean		<i>n</i>		Std. Dev.		Mean		<i>n</i>		Std. Dev.	
	left	right			left	right	left	right			left	right
XL5	27.41		31		2.12		26.98		22		1.81	
S1	30.06		35		2.24		29.83		18		1.97	
SML	108.63		34		9.05		106.15		17		8.33	
HML	299.48	305.19	31	29	18.40	20.42	281.06	283.11	17	18	14.30	14.46
HEB	61.30	62.91	30	29	3.13	3.39	55.85	56.67	17	18	3.70	3.49
HHD	45.48	45.55	31	29	2.42	2.60	40.27	40.60	17	18	1.99	2.28
HMLD	24.47	24.88	31	29	1.82	1.98	20.72	21.09	18	19	2.48	2.09
HAPD	21.96	22.85	31	29	1.94	1.73	19.34	19.91	18	19	2.02	1.82
HAB	43.46	43.51	31	29	2.23	2.65	39.52	39.43	17	19	1.91	2.24
RML	229.33	233.00	24	26	13.55	11.60	208.62	213.28	17	18	8.61	12.48
RMLD	16.14	16.31	24	26	1.35	1.40	14.85	14.90	17	18	1.68	1.79
RAPD	11.73	12.02	24	26	0.84	0.62	10.08	10.28	17	18	0.69	0.85
RMLH	21.62	22.19	25	27	1.30	1.30	19.42	19.68	18	19	0.99	1.64
RAPH	22.84	23.15	23	28	1.32	1.25	20.55	20.94	15	17	1.08	1.65
RAB	26.33	26.44	24	27	1.54	1.47	24.31	24.65	17	18	1.19	1.51
UML	248.08	253.32	24	25	13.97	10.89	228.71	233.42	17	18	7.07	11.42
UMLD	12.79	13.34	24	25	1.08	0.83	11.40	11.46	17	18	0.83	0.87
UAPD	15.66	16.33	24	25	1.38	1.99	13.96	14.57	17	18	1.20	1.21
FML	415.64	415.82	35	34	27.00	26.94	389.97	385.21	16	17	18.88	21.98
FBL	413.97	415.50	35	33	27.09	26.42	387.97	383.21	16	17	18.78	21.71
FEB	80.21	80.85	34	31	3.16	3.20	73.93	73.72	15	16	3.42	3.54
FAB	70.21	70.59	34	31	3.35	3.35	64.22	64.36	16	16	3.56	3.86
FHD	45.34	45.72	34	34	2.08	2.18	41.67	41.16	16	17	2.49	2.54
FMLD	27.62	27.51	35	34	1.49	1.42	24.81	25.21	16	17	1.45	2.03
FAPD	29.28	29.56	35	34	2.17	2.24	26.65	26.26	16	17	1.65	1.86
TML	337.77	336.19	33	35	22.50	22.54	313.69	311.80	16	20	19.66	18.30
TFL	333.62	332.39	33	35	22.43	22.41	309.69	308.08	16	20	19.59	18.36
TPB	74.86	74.70	33	32	3.58	3.77	69.93	69.36	15	18	3.97	4.35
TPAB	73.37	73.50	33	32	3.52	3.64	67.64	67.53	15	18	4.36	4.12
TMLD	22.02	22.77	34	35	1.59	1.83	19.62	20.34	15	20	1.66	1.50
TAPD	28.79	28.26	34	35	1.73	1.53	24.99	24.80	15	20	1.98	2.09
FIML	326.83	328.67	27	29	21.81	21.58	310.58	303.69	13	18	13.96	19.11
BIB	262.99		35		13.37		259.47		18		10.60	
IBL	156.31	156.41	29	29	8.41	8.58	149.94	152.65	17	17	7.77	8.33
ACH	50.14	50.04	35	32	2.19	2.39	46.25	45.96	20	18	2.33	2.47
TCH	66.75	67.80	22	23	3.24	2.61	61.89	61.63	9	8	2.63	2.30
TTB	30.05	30.24	23	24	1.72	1.31	27.07	27.00	11	8	2.14	1.96

IKOGMIUT

Dimension	MALES						FEMALES					
	Mean		<i>n</i>	Std. Dev.		Mean		<i>n</i>	Std. Dev.			
	left	right		left	right	left	right		left	right		
BBH	137.04		27	5.72		129.32		31	5.02			
GBL	179.93		27	6.47		171.45		31	4.91			
EUB	139.46		26	4.55		133.65		31	4.10			
UFH	85.61		27	6.19		80.50		31	6.31			
NAH	29.72		27	2.72		26.88		31	2.39			
NAW	24.04		27	2.04		23.38		31	1.48			
ZYG	137.00		26	3.88		129.19		31	4.03			
JNB	26.31		17	2.34		23.44		20	2.55			
CML	152.86	148.98	28	27	8.63	7.56	137.75	134.31	24	26	7.55	8.92
CAPD	10.39	10.89	28	27	1.07	1.10	9.31	9.46	24	26	1.01	0.87
CSID	10.05	10.34	28	27	1.05	1.31	8.34	8.79	24	26	0.81	0.91
C1	10.69		25	1.07		9.80		26	1.18			
XC2	37.24		26	2.48		34.60		25	2.42			
XC3	12.72		26	0.76		11.32		25	0.85			
XC4	12.36		24	0.97		11.09		23	0.82			
XC5	12.20		23	1.11		11.15		24	1.01			
XC6	11.98		24	1.05		11.46		25	0.73			
XC7	13.65		24	0.97		12.69		25	0.70			
XT1	15.87		24	0.78		14.88		26	0.81			
XT2	18.10		25	0.95		16.68		27	0.87			
XT3	18.39		25	1.00		16.82		27	1.00			
XT4	18.79		24	1.11		17.22		27	1.08			
XT5	19.38		23	1.18		17.55		26	1.17			
XT6	19.44		24	1.11		17.63		26	1.43			
XT7	19.63		24	1.16		18.06		26	1.40			
XT8	19.95		25	1.16		18.72		26	1.12			
XT9	20.48		24	1.13		19.19		27	1.32			
XT10	21.10		24	1.03		19.83		27	1.69			
XT11	21.41		24	1.37		20.33		27	1.81			
XT12	22.48		24	1.82		21.92		27	1.67			
XL1	23.72		25	1.70		23.88		27	5.07			
XL2	24.45		25	1.91		24.25		25	1.69			
XL3	25.15		26	2.24		24.72		26	1.49			
XL4	25.58		26	1.90		24.66		26	1.45			

IKOGMIUT, CONTINUED

Dimension	MALES						FEMALES					
	Mean		<i>n</i>		Std. Dev.		Mean		<i>n</i>		Std. Dev.	
	left	right			left	right	left	right			left	right
XL5	26.00		27		2.33		24.10		28		1.96	
S1	29.73		28		2.40		28.39		30		2.26	
SML	106.88		26		8.97		99.56		27		7.42	
HML	313.14	314.14	28	26	15.06	18.69	283.02	290.57	29	27	10.02	11.68
HEB	60.63	60.54	27	24	2.72	3.24	52.19	52.52	24	22	3.67	3.54
HHD	44.70	45.18	29	26	2.04	2.13	39.39	39.99	27	28	1.63	2.19
HMLD	22.65	22.25	29	26	2.24	2.02	18.16	18.33	28	27	1.36	1.15
HAPD	21.32	21.90	29	26	1.76	1.68	18.51	18.95	29	27	1.46	1.64
HAB	43.21	43.51	27	26	1.48	1.76	37.19	37.80	24	22	2.32	2.10
RML	234.71	234.28	26	27	12.66	14.06	209.32	209.83	27	21	11.65	14.08
RMLD	15.20	15.30	27	27	1.01	1.28	13.24	13.28	29	25	1.20	0.96
RAPD	11.43	11.29	27	27	0.90	0.84	9.69	9.75	29	25	0.63	0.65
RMLH	21.42	21.27	26	25	1.18	1.21	18.46	18.37	24	19	1.38	1.20
RAPH	22.13	22.24	26	24	1.37	1.34	18.98	19.08	22	17	1.45	1.13
RAB	26.64	26.90	26	27	1.33	1.33	24.08	24.20	28	23	1.69	1.35
UML	253.33	253.67	26	27	13.51	13.90	229.88	232.14	24	21	12.67	13.53
UMLD	13.09	13.50	26	27	1.10	0.80	11.36	12.03	23	23	0.96	1.22
UAPD	14.69	14.42	26	27	1.45	1.36	12.44	12.53	23	23	1.29	1.32
FML	429.15	425.53	27	29	22.18	26.80	399.38	400.87	30	30	19.31	16.91
FBL	426.28	422.48	27	29	21.48	25.99	395.10	397.76	29	29	17.99	16.70
FEB	77.11	77.43	27	28	4.02	4.21	70.77	71.00	22	26	3.96	3.89
FAB	67.50	67.31	27	28	3.76	3.86	61.12	61.28	22	25	3.87	3.69
FHD	45.88	45.71	27	29	2.34	2.21	41.33	41.59	31	30	2.23	2.06
FMLD	26.12	25.90	27	29	1.33	1.74	23.31	23.12	30	30	1.74	1.47
FAPD	28.59	28.60	27	29	2.22	2.59	24.78	25.17	30	30	1.74	2.01
TML	347.89	349.16	28	29	22.17	22.87	319.15	320.19	31	29	15.64	14.60
TFL	343.32	344.83	28	29	21.91	22.49	315.29	316.92	31	29	15.78	14.54
TPB	72.50	72.44	26	26	3.33	2.93	65.92	65.43	24	22	3.82	3.32
TPAB	70.72	70.95	26	26	3.72	3.26	63.77	63.89	24	22	3.79	3.34
TMLD	20.25	21.36	28	29	1.98	1.78	18.67	19.59	31	29	1.38	1.71
TAPD	27.07	26.99	28	29	2.47	2.49	22.94	22.95	31	29	1.44	1.51
FIML	337.07	340.44	27	25	21.17	20.27	311.96	308.05	25	21	14.98	14.31
BIB	264.85		27		16.23		259.00		30		14.07	
IBL	153.59	154.54	22	24	8.68	8.31	146.80	147.32	25	25	6.38	8.01
ACH	51.10	50.85	28	29	2.08	2.32	46.24	46.33	30	30	2.06	2.28
TCH	65.95	66.31	20	21	4.22	3.79	60.59	60.65	22	23	3.66	3.23
TTB	27.48	27.69	19	21	2.07	1.89	25.08	24.98	23	24	1.54	1.54

KUSKOWAGAMIUT

Dimension	MALES						FEMALES					
	Mean		n	Std. Dev.		Mean		n	Std. Dev.			
	left	right		left	right	left	right		left	right		
BBH	135.69		13	4.97		129.00		13	4.95			
GBL	179.85		13	7.06		173.77		13	6.55			
EUB	139.00		13	6.61		136.50		12	3.45			
UFH	86.25		13	2.63		79.18		12	3.90			
NAH	28.84		13	2.16		26.56		12	1.84			
NAW	23.76		13	1.37		23.67		13	1.18			
ZYG	138.31		13	6.05		131.92		12	4.96			
JNB	26.94		7	1.43		24.48		9	3.54			
CML	149.04	146.39	11	14	8.89	8.64	135.69	135.08	13	12	10.29	9.07
CAPD	10.30	10.87	11	14	1.25	1.14	9.11	9.77	13	12	0.77	0.88
CSID	9.75	10.20	11	14	1.00	1.43	8.38	8.49	13	12	0.96	1.06
C1	10.15		8	1.42		10.23		14	1.04			
XC2	35.99		10	3.03		34.04		13	1.84			
XC3	12.25		10	1.31		11.42		13	1.07			
XC4	12.13		13	1.14		10.74		13	1.11			
XC5	12.12		13	1.22		10.83		13	1.18			
XC6	12.22		14	0.89		11.22		14	1.10			
XC7	13.49		14	1.10		12.61		14	0.78			
XT1	15.71		14	1.18		14.65		14	0.80			
XT2	17.67		14	1.00		16.57		14	0.96			
XT3	18.04		14	1.02		16.72		13	0.89			
XT4	18.46		14	1.00		17.25		13	0.87			
XT5	18.98		14	1.01		17.79		14	1.11			
XT6	19.70		14	1.11		17.90		14	1.17			
XT7	20.02		14	1.13		17.80		14	1.18			
XT8	20.11		14	1.32		18.18		14	0.81			
XT9	20.58		14	1.03		18.81		14	1.15			
XT10	21.33		14	1.16		19.91		14	0.97			
XT11	21.05		14	0.78		20.00		14	0.86			
XT12	22.33		14	1.39		21.25		14	1.07			
XL1	23.54		14	1.07		22.50		14	1.20			
XL2	24.03		14	1.22		23.24		14	1.21			
XL3	25.00		14	1.32		23.66		14	1.88			
XL4	25.59		14	1.76		24.51		14	1.49			

KUSKOWAGAMIUT, CONTINUED

Dimension	MALES						FEMALES					
	Mean		n		Std. Dev.		Mean		n		Std. Dev.	
	left	right			left	right	left	right			left	right
XL5	25.34		14		1.85		24.55		14		1.56	
S1	28.69		14		2.52		28.34		14		1.80	
SML	108.21		14		8.22		103.85		13		13.09	
HML	306.18	309.71	11	14	12.53	9.66	285.17	292.05	11	12	13.17	13.59
HEB	57.00	58.25	10	14	2.49	3.02	51.71	52.08	12	12	4.59	3.90
HHD	44.84	45.36	11	13	3.03	2.78	38.74	40.21	12	12	1.99	2.00
HMLD	22.07	22.31	11	14	1.69	1.56	18.87	18.94	14	12	2.04	1.87
HAPD	21.60	22.53	11	14	1.56	1.80	18.74	19.43	14	12	1.69	1.51
HAB	42.00	43.34	10	14	2.82	1.81	38.42	39.69	12	12	2.54	1.85
RML	227.64	231.18	11	11	6.91	8.00	211.23	213.32	11	11	14.35	12.36
RMLD	14.60	14.57	12	11	1.37	1.28	13.13	13.59	12	12	1.28	1.01
RAPD	11.19	10.90	12	11	0.70	0.81	9.72	9.92	12	12	0.74	0.57
RMLH	20.70	21.74	9	10	1.83	1.16	19.33	19.67	12	10	1.53	1.47
RAPH	20.93	21.69	9	12	1.86	1.30	19.84	19.63	12	10	1.58	1.83
RAB	26.27	25.85	12	10	1.73	2.07	23.78	24.70	11	11	1.31	1.33
UML	249.00	249.73	12	11	6.09	7.65	230.70	229.63	12	10	11.69	13.31
UMLD	13.19	13.41	12	12	0.86	1.25	11.36	11.71	12	10	0.91	1.20
UAPD	14.63	14.27	12	12	1.15	1.35	12.47	12.92	12	10	1.10	1.05
FML	427.39	421.07	13	14	15.53	13.51	400.11	399.43	14	14	18.15	18.13
FBL	423.89	418.64	13	14	15.88	13.40	396.43	396.25	14	14	18.11	17.85
FEB	75.05	76.88	11	12	3.22	2.77	71.71	71.35	13	12	2.71	2.54
FAB	65.50	66.32	12	13	2.86	2.66	62.28	60.99	13	12	2.45	2.43
FHD	45.98	45.99	13	14	2.30	2.19	41.41	41.45	13	14	2.44	2.57
FMLD	24.97	25.38	13	14	1.35	1.24	23.32	23.55	14	14	1.15	0.95
FAPD	27.30	27.81	13	14	1.46	2.06	25.84	26.12	14	14	1.69	1.91
TML	333.32	333.73	14	13	12.88	11.52	319.00	320.79	14	14	15.85	15.33
TFL	329.54	329.83	14	13	12.30	11.38	314.79	316.32	14	14	15.37	15.55
TPB	69.67	71.82	12	11	3.05	3.41	67.23	66.25	12	11	2.62	2.62
TPAB	67.74	70.20	12	11	2.60	3.48	65.20	64.51	12	11	2.86	2.43
TMLD	20.30	21.40	14	13	1.42	1.55	19.09	20.05	14	14	1.11	1.05
TAPD	26.38	26.45	14	13	1.07	1.32	24.27	24.33	14	14	1.18	1.96
FIML	321.15	324.39	10	9	13.78	12.33	307.50	309.50	13	12	12.72	15.48
BIB	265.11		14		13.99		254.50		14		13.00	
IBL	152.30	153.31	10	13	6.36	8.52	145.83	148.08	12	12	5.75	7.00
ACH	50.54	50.69	14	13	1.69	2.34	46.97	47.35	14	14	2.89	2.90
TCH	63.70	64.58	10	12	3.97	3.06	61.29	61.27	12	11	2.58	2.94
TTB	27.47	27.67	11	10	1.35	1.39	26.10	26.71	13	13	1.00	0.70

POINT BARROW

Dimension	MALES						FEMALES					
	Mean		n	Std. Dev.		Mean		n	Std. Dev.			
	left	right		left	right	left	right		left	right		
BBH	137.89		18	5.59		131.00		9	4.85			
GBL	186.06		18	5.72		176.44		9	5.88			
EUB	130.59		17	3.91		126.38		8	6.14			
UFH	83.57		18	4.88		77.45		8	7.17			
NAH	32.40		18	3.05		28.39		8	2.46			
NAW	23.51		18	1.79		21.65		8	2.95			
ZYG	136.88		17	6.58		124.71		7	5.94			
JNB	29.17		9	3.43		24.92		4	2.92			
CML	147.86	146.23	11	15	8.43	10.19	147.86	146.23	11	15	8.43	10.19
CAPD	10.50	10.90	11	15	1.17	1.43	10.50	10.90	11	15	1.17	1.43
CSID	10.02	10.33	11	15	0.94	1.10	10.02	10.33	11	15	0.94	1.10
C1	11.16		15	0.97		9.68		4	1.81			
XC2	35.88		16	2.49		33.73		5	2.42			
XC3	11.26		16	1.12		11.36		5	0.83			
XC4	11.30		14	1.06		10.85		5	0.71			
XC5	10.70		13	.84		10.37		4	0.57			
XC6	11.05		14	.99		9.80		5	1.36			
XC7	12.21		13	.84		11.28		5	0.87			
XT1	14.76		15	1.41		13.99		5	0.93			
XT2	17.03		14	1.58		15.95		5	0.96			
XT3	17.25		14	1.12		16.15		5	1.16			
XT4	17.03		14	1.22		16.63		5	0.51			
XT5	17.49		15	1.09		16.69		5	1.30			
XT6	18.99		14	3.46		17.21		5	1.34			
XT7	18.86		13	1.32		18.78		5	1.22			
XT8	19.16		14	1.23		19.10		5	0.96			
XT9	19.85		14	.98		19.79		5	1.10			
XT10	20.49		14	1.14		20.52		5	1.31			
XT11	20.53		15	.97		20.37		5	1.94			
XT12	21.85		15	1.13		22.68		5	0.97			
XL1	23.29		16	1.42		24.14		5	1.54			
XL2	23.79		15	1.37		24.05		5	1.26			
XL3	23.95		15	1.40		24.19		5	1.45			
XL4	24.14		14	1.37		24.24		5	0.60			

POINT BARROW, CONTINUED

Dimension	MALES						FEMALES					
	Mean		n		Std. Dev.		Mean		n		Std. Dev.	
	left	right			left	right	left	right			left	right
XL5	24.08		14		1.63		23.87		5		2.19	
S1	27.72		14		1.91		27.09		6		1.81	
SML	110.00		13		12.09		102.48		6		11.25	
HML	306.65	309.40	13	15	13.83	16.58	306.65	309.40	13	15	13.83	16.58
HEB	60.33	60.14	12	14	2.65	3.37	60.33	60.14	12	14	2.65	3.37
HHD	44.50	44.81	14	15	2.38	2.70	44.50	44.81	14	15	2.38	2.70
HMLD	23.31	23.65	14	15	2.59	2.56	23.31	23.65	14	15	2.59	2.56
HAPD	22.06	22.75	14	15	1.52	2.15	22.06	22.75	14	15	1.52	2.15
HAB	42.30	41.70	12	14	2.24	1.88	42.30	41.70	12	14	2.24	1.88
RML	231.67	231.21	12	14	11.25	13.34	231.67	231.21	12	14	11.25	13.34
RMLD	14.75	14.30	12	14	1.30	1.24	14.75	14.30	12	14	1.30	1.24
RAPD	11.77	11.46	12	14	.93	1.06	11.77	11.46	12	14	.93	1.06
RMLH	20.89	20.73	12	12	1.28	1.52	20.89	20.73	12	12	1.28	1.52
RAPH	21.37	21.28	11	11	1.40	1.37	21.37	21.28	11	11	1.40	1.37
RAB	25.30	25.54	11	13	1.87	.91	25.30	25.54	11	13	1.87	.91
UML	250.50	253.32	11	11	12.07	9.58	250.50	253.32	11	11	12.07	9.58
UMLD	12.67	13.71	11	11	1.03	1.16	12.67	13.71	11	11	1.03	1.16
UAPD	15.20	15.51	11	11	2.21	1.65	15.20	15.51	11	11	2.21	1.65
FML	430.89	432.03	14	15	20.88	21.20	430.89	432.03	14	15	20.88	21.20
FBL	428.62	430.03	13	15	21.72	20.93	428.62	430.03	13	15	21.72	20.93
FEB	77.73	80.28	11	9	3.89	2.48	77.73	80.28	11	9	3.89	2.48
FAB	68.84	70.57	11	10	4.19	3.50	68.84	70.57	11	10	4.19	3.50
FHD	46.53	47.05	15	16	2.42	1.97	46.53	47.05	15	16	2.42	1.97
FMLD	28.27	27.73	14	15	2.47	2.15	28.27	27.73	14	15	2.47	2.15
FAPD	31.53	31.89	14	15	2.85	3.02	31.53	31.89	14	15	2.85	3.02
TML	356.04	352.29	14	14	19.40	23.63	356.04	352.29	14	14	19.40	23.63
TFL	351.03	348.21	14	14	19.03	23.12	351.03	348.21	14	14	19.03	23.12
TPB	73.69	67.29	8	6	3.12	18.57	73.69	67.29	8	6	3.12	18.57
TPAB	70.89	70.88	9	6	2.77	5.70	70.89	70.88	9	6	2.77	5.70
TMLD	22.24	23.03	14	14	1.56	1.71	22.24	23.03	14	14	1.56	1.71
TAPD	28.80	27.19	14	14	1.99	2.30	28.80	27.19	14	14	1.99	2.30
FIML	349.25	343.29	13	7	21.70	14.42	349.25	343.29	13	7	21.70	14.42
BIB	275.35		13		14.16		256.08		6		16.40	
IBL	155.54	156.09	11	11	6.46	7.20	155.54	156.09	11	11	6.46	7.20
ACH	52.11	51.67	15	14	1.97	2.72	52.11	51.67	15	14	1.97	2.72
TCH	66.89	67.54	9	12	1.92	3.45	66.89	67.54	9	12	1.92	3.45
TTB	28.35	28.95	10	12	1.37	1.06	28.35	28.95	10	12	1.37	1.06

IPIUTAK (POINT HOPE)

Dimension	MALES						FEMALES					
	Mean		n	Std. Dev.		Mean		n	Std. Dev.			
	left	right		left	right	left	right		left	right		
BBH	85.57		18	3.53		128.71		14	4.41			
GBL	29.17		16	2.59		175.14		14	5.61			
EUB	23.89		17	1.28		135.64		14	4.05			
UFH	137.61		18	4.33		81.46		13	5.32			
NAH	24.95		9	2.98		28.05		10	1.85			
NAW	29.17		16	2.59		23.49		12	1.66			
ZYG	23.89		17	1.28		131.31		13	5.33			
JNB	137.61		18	4.33		23.30		7	2.63			
CML	145.97	144.53	17	17	9.39	10.09	129.53	127.65	15	13	5.87	7.29
CAPD	11.57	12.18	16	17	1.28	1.07	9.90	10.29	15	13	1.04	1.04
CSID	10.63	10.41	17	17	1.45	1.00	8.53	8.86	15	13	1.00	1.19
C1	10.28		18	1.22		10.71		15	1.12			
XC2	37.02		18	3.34		34.30		15	2.70			
XC3	12.23		17	0.97		12.72		15	3.41			
XC4	11.61		18	1.22		11.38		14	0.74			
XC5	11.49		18	0.98		11.25		15	0.74			
XC6	11.61		19	1.08		10.97		15	0.73			
XC7	12.99		18	1.19		12.16		14	0.95			
XT1	14.96		17	1.11		14.36		15	0.72			
XT2	16.68		17	1.18		15.80		15	0.95			
XT3	16.77		17	1.42		15.87		14	1.05			
XT4	17.40		18	0.99		16.35		14	0.94			
XT5	17.94		18	1.43		17.14		14	0.96			
XT6	18.75		17	1.45		17.72		14	0.87			
XT7	19.21		18	1.29		17.90		14	1.03			
XT8	19.62		18	1.43		18.71		13	0.94			
XT9	20.49		18	1.27		18.78		14	1.61			
XT10	21.03		18	1.52		19.60		14	0.76			
XT11	21.86		18	1.68		20.12		15	1.06			
XT12	23.24		18	1.50		21.82		15	1.39			
XL1	24.35		18	1.62		23.01		15	1.73			
XL2	24.00		18	1.86		23.61		15	1.33			
XL3	24.49		18	1.66		23.77		13	1.68			
XL4	25.60		19	1.55		24.30		14	1.53			

IPIUTAK, CONTINUED

Dimension	MALES						FEMALES					
	Mean		<i>n</i>		Std. Dev.		Mean		<i>n</i>		Std. Dev.	
	left	right			left	right	left	right			left	right
XL5	25.86		19		1.62		24.82		14		2.04	
S1	29.23		17		2.47		27.74		16		2.58	
SML	105.83		13		9.39		104.16		8		7.95	
HML	302.14	305.87	18	19	19.28	19.48	283.93	286.29	14	14	10.01	10.61
HEB	60.94	61.29	17	17	3.01	2.51	53.43	53.82	14	14	2.41	2.66
HHD	44.43	45.10	17	19	1.41	1.55	39.97	39.84	13	14	3.05	3.02
HMLD	21.98	22.24	18	19	1.78	1.98	18.13	18.81	14	14	1.31	1.80
HAPD	21.17	21.90	18	19	1.47	1.57	19.64	20.10	14	14	1.95	1.72
HAB	42.52	43.68	17	17	1.54	1.66	38.21	38.57	14	14	2.14	2.16
RML	230.87	230.39	15	18	11.96	13.66	204.77	206.96	13	12	6.84	10.83
RMLD	15.24	15.78	15	18	1.20	1.25	14.24	14.41	13	12	1.59	1.30
RAPD	11.64	11.29	15	18	0.61	0.55	9.83	9.86	13	12	0.82	0.44
RMLH	20.41	20.75	16	18	1.06	1.17	19.15	18.83	12	15	1.23	.97
RAPH	21.20	21.62	15	17	1.19	0.97	19.69	19.12	11	14	.89	1.16
RAB	25.01	25.40	17	18	1.13	1.28	23.18	23.61	13	12	1.26	1.50
UML	250.85	250.41	17	16	14.48	14.55	223.96	221.65	12	13	5.97	9.40
UMLD	12.90	12.76	17	16	1.14	0.82	12.14	11.27	12	13	1.26	0.72
UAPD	15.53	16.42	17	16	1.63	1.65	13.54	13.83	12	13	1.38	0.99
FML	420.06	418.97	17	19	30.51	29.57	386.88	386.63	16	16	13.34	13.88
FBL	417.74	416.05	17	19	29.73	28.30	384.13	383.94	16	16	13.58	13.32
FEB	79.53	79.87	17	19	3.34	3.29	71.03	70.90	15	15	3.14	2.92
FAB	69.90	70.15	17	19	2.89	3.09	60.97	61.06	15	15	2.84	3.23
FHD	45.75	46.07	17	19	1.78	1.65	41.09	41.27	16	16	2.28	2.28
FMLD	27.26	26.98	17	19	1.60	1.46	25.40	25.50	16	16	1.60	1.26
FAPD	28.98	29.02	17	19	1.35	1.76	26.12	26.28	16	16	2.22	1.92
TML	336.50	338.79	17	19	22.32	21.97	309.18	308.06	14	16	11.25	11.58
TFL	332.77	334.42	17	19	21.59	21.36	306.21	310.19	14	16	10.93	23.18
TPB	74.78	75.19	18	16	3.41	3.42	66.58	66.93	13	14	2.91	3.46
TPAB	72.32	73.36	18	16	2.85	3.51	64.79	64.61	15	14	3.29	3.06
TMLD	20.87	22.07	18	19	.83	1.17	19.06	19.87	14	16	1.44	1.55
TAPD	27.14	27.53	18	19	1.78	1.82	23.39	23.34	14	16	1.27	1.49
FIML	326.38	326.19	12	16	19.62	20.06	297.65	300.81	10	8	12.42	10.87
BIB	274.83		15		13.47		268.32		14		11.87	
IBL	157.67	157.63	12	16	6.76	7.34	153.92	152.39	12	13	6.99	6.54
ACH	51.05	50.75	15	18	2.41	2.21	46.08	45.65	16	16	2.51	2.35
TCH	66.50	65.22	13	16	2.77	2.55	60.81	59.00	13	11	2.92	2.64
TTB	29.26	29.92	15	17	1.38	1.45	26.70	26.99	13	13	1.20	1.09

TIGARA (POINT HOPE)

Dimension	MALES						FEMALES					
	Mean		n	Std. Dev.		Mean		n	Std. Dev.			
	left	right		left	right	left	right		left	right		
BBH	140.05		20	4.84		132.05		20	3.39			
GBL	185.65		20	5.76		174.55		20	4.66			
EUB	135.00		20	6.63		133.30		20	5.18			
UFH	86.03		20	3.90		78.72		20	3.77			
NAH	30.10		15	3.13		27.06		17	2.21			
NAW	23.41		20	1.24		23.41		20	1.37			
ZYG	140.35		20	4.49		131.30		20	3.61			
JNB	26.86		14	3.07		23.32		9	1.94			
CML	146.97	142.67	17	18	6.77	7.75	130.60	128.53	20	20	6.20	4.90
CAPD	11.00	11.03	17	17	1.25	1.31	9.45	9.51	19	20	1.17	0.93
CSID	10.37	10.10	17	17	1.39	1.50	8.57	8.32	20	20	0.94	0.76
C1	11.20		21	1.25		9.88		22	1.32			
XC2	36.28		21	2.44		32.87		22	1.67			
XC3	11.98		21	1.13		10.70		22	0.94			
XC4	11.95		19	0.90		10.81		21	0.78			
XC5	11.66		19	0.83		10.28		22	1.07			
XC6	11.51		21	0.63		10.51		22	0.96			
XC7	12.71		21	0.71		11.74		22	1.06			
XT1	14.99		20	0.64		14.13		21	1.13			
XT2	17.11		19	0.81		16.01		21	1.17			
XT3	17.49		19	1.04		16.11		21	0.90			
XT4	17.87		19	0.94		16.58		22	0.72			
XT5	18.09		21	0.92		16.89		22	1.04			
XT6	18.97		20	1.19		17.42		22	1.47			
XT7	19.72		20	0.92		17.85		22	1.12			
XT8	20.07		20	0.93		18.33		22	1.11			
XT9	20.87		20	1.33		19.02		22	1.29			
XT10	21.96		19	1.62		20.05		22	0.87			
XT11	22.20		19	1.34		20.09		22	0.97			
XT12	23.34		18	1.66		21.75		22	1.29			
XL1	24.28		19	1.55		22.89		22	1.46			
XL2	24.91		19	1.58		23.65		22	1.71			
XL3	25.40		20	1.54		24.27		22	1.26			
XL4	26.92		21	5.64		24.29		22	1.36			

TIGARA, CONTINUED

Dimension	MALES						FEMALES					
	Mean		n		Std. Dev.		Mean		n		Std. Dev.	
	left	right			left	right	left	right			left	right
XL5	26.41		20		3.77		23.93		22		1.51	
S1	29.27		22		1.70		27.10		22		2.86	
SML	104.32		19		9.40		101.01		16		10.86	
HML	299.84	304.05	22	20	15.61	16.76	276.80	282.84	22	22	10.07	11.06
HEB	59.53	58.98	20	20	3.48	3.54	53.07	53.55	21	21	2.85	2.98
HHD	44.47	44.69	22	20	3.22	3.02	39.58	39.94	22	22	1.78	2.04
HMLD	21.77	21.88	22	20	2.06	1.79	18.51	18.75	22	22	1.79	1.85
HAPD	21.29	21.96	22	20	1.72	2.01	18.74	19.29	22	22	1.24	1.50
HAB	43.58	43.58	20	19	2.75	2.90	39.28	39.24	21	22	2.62	2.74
RML	225.55	228.45	19	19	13.61	10.55	202.95	205.98	20	22	8.85	8.99
RMLD	14.96	15.67	19	19	1.17	1.06	12.96	13.53	20	22	1.49	1.23
RAPD	11.03	11.49	19	19	0.83	0.84	9.69	9.78	20	22	0.74	0.69
RMLH	20.82	21.52	18	21	1.55	1.61	18.70	19.05	20	21	1.15	1.36
RAPH	21.69	22.00	19	21	1.81	1.50	19.21	19.26	21	22	1.29	1.26
RAB	25.68	26.28	19	20	1.80	1.38	22.97	23.03	20	22	1.44	1.35
UML	246.66	245.95	16	19	13.51	12.41	224.58	226.70	20	20	9.00	9.59
UMLD	13.14	13.01	16	19	1.39	1.21	11.13	11.49	20	20	1.02	1.10
UAPD	14.98	14.90	16	19	1.53	1.21	12.16	13.05	20	20	0.84	1.18
FML	431.71	432.55	22	21	21.02	22.06	395.11	394.68	22	22	17.77	17.26
FBL	429.26	429.41	21	21	21.86	22.80	392.43	392.33	22	21	17.33	18.07
FEB	81.00	81.22	20	20	3.90	4.47	72.67	72.33	18	18	3.12	2.79
FAB	72.02	71.96	20	21	4.33	4.03	63.14	63.07	20	21	3.51	3.04
FHD	46.81	47.37	20	22	2.72	2.73	42.09	42.32	21	22	1.55	1.61
FMLD	27.78	27.64	22	21	1.49	1.48	24.57	24.49	22	22	1.55	1.53
FAPD	31.43	31.66	22	21	1.89	2.18	28.08	28.18	22	22	1.83	1.91
TML	354.28	356.43	20	22	21.94	19.98	324.02	322.87	21	19	16.84	15.82
TFL	349.85	351.16	20	22	20.90	19.18	320.24	319.11	21	19	16.84	15.96
TPB	74.63	76.41	20	22	4.55	3.74	67.82	68.22	19	18	2.99	3.05
TPAB	73.05	74.75	20	22	4.55	3.72	65.88	66.37	19	18	2.94	2.59
TMLD	21.87	22.98	20	22	1.13	1.49	19.37	20.15	21	19	1.32	1.11
TAPD	27.88	28.13	20	22	1.83	1.54	24.91	24.30	21	19	1.63	1.75
FIML	342.13	340.56	16	17	17.90	18.01	314.18	315.92	17	18	15.63	16.21
BIB	280.14		22		11.21		263.41		22		12.35	
IBL	164.65	160.41	20	17	5.21	6.89	146.43	147.04	21	22	6.15	4.92
ACH	52.51	52.17	22	22	3.77	2.91	47.26	47.32	22	22	1.91	1.91
TCH	66.62	65.93	17	20	4.42	4.35	59.94	58.65	18	17	2.84	3.29
TTB	30.57	30.84	17	21	1.88	1.60	26.91	27.36	19	18	1.58	1.66

CANYON DEL MUERTO

Dimension	MALES						FEMALES					
	Mean		n	Std. Dev.		Mean		n	Std. Dev.			
	left	right		left	right	left	right		left	right		
BBH	134.82		11	5.69		127.22		9	4.58			
GBL	174.36		11	11.03		163.00		9	10.70			
EUB	136.54		11	7.20		134.44		9	6.35			
UFH	83.53		11	3.96		76.95		9	3.34			
NAH	29.42		11	2.52		26.36		9	2.03			
NAW	25.03		11	1.35		25.24		9	1.31			
ZYG	135.73		11	7.04		127.78		9	3.99			
JNB	25.08		10	3.19		22.73		7	4.22			
CML	150.22	147.27	9	11	5.30	6.49	138.19	135.56	8	8	5.08	4.44
CAPD	10.22	10.92	9	11	0.86	1.24	9.30	9.05	8	8	0.59	0.66
CSID	9.32	9.69	9	11	0.53	0.85	7.94	7.75	8	8	0.84	0.66
C1	10.74		10	0.94		10.37		9	1.23			
XC2	34.98		9	2.67		33.92		10	3.48			
XC3	13.56		8	1.01		12.66		10	0.92			
XC4	13.25		8	0.73		12.12		8	1.29			
XC5	12.56		9	0.78		11.78		9	1.34			
XC6	12.81		10	0.89		11.59		10	1.14			
XC7	14.06		9	0.63		13.63		6	1.29			
XT1	16.00		10	1.02		15.34		7	1.36			
XT2	17.96		10	0.77		16.29		10	1.39			
XT3	18.06		10	0.72		16.41		10	1.49			
XT4	17.94		10	1.01		17.12		10	1.31			
XT5	18.64		11	0.79		17.23		10	1.53			
XT6	19.44		10	0.94		17.54		10	1.45			
XT7	20.02		9	1.00		17.79		10	1.56			
XT8	20.45		10	1.55		18.52		10	1.53			
XT9	20.63		11	1.35		19.04		10	1.51			
XT10	21.44		11	1.07		19.90		10	1.36			
XT11	22.61		11	0.93		20.68		10	1.58			
XT12	24.16		11	1.27		22.91		10	1.46			
XL1	24.87		11	1.53		24.28		9	1.35			
XL2	26.01		10	1.58		25.00		10	1.44			
XL3	26.63		10	1.63		25.94		10	1.12			
XL4	27.69		11	1.87		26.78		10	0.80			

CANYON DEL MUERTO, CONTINUED

Dimension	MALES						FEMALES					
	Mean		n		Std. Dev.		Mean		n		Std. Dev.	
	left	right			left	right	left	right			left	right
XL5	28.34		11		2.20		27.17		10		1.24	
S1	30.10		10		2.33		28.18		10		2.14	
SML	111.67		10		13.88		99.19		10		15.71	
HML	309.65	309.06	13	17	15.60	13.21	279.91	283.45	11	10	10.30	10.80
HEB	59.35	59.38	13	17	3.24	3.07	52.64	52.25	11	10	3.03	3.42
HHD	42.93	43.69	13	17	2.54	2.24	37.25	37.65	11	10	1.56	1.58
HMLD	19.61	20.50	13	17	1.38	1.25	19.46	19.36	11	10	1.14	1.28
HAPD	18.32	19.61	13	17	1.49	1.25	17.14	17.60	11	10	1.68	1.58
HAB	41.43	41.60	9	11	1.77	1.91	37.88	38.64	10	8	1.96	2.22
RML	242.46	245.29	14	17	14.12	13.16	218.50	219.70	9	10	6.91	7.24
RMLD	12.93	12.53	14	17	1.49	3.37	12.68	13.06	9	10	1.16	1.54
RAPD	10.72	11.16	14	17	0.45	0.61	10.74	10.94	9	10	1.18	1.47
RMLH	20.38	21.22	10	12	1.47	1.32	18.89	19.51	8	9	1.30	1.10
RAPH	20.94	21.66	10	12	1.83	1.45	19.28	19.51	8	9	1.21	1.01
RAB	23.97	24.40	10	12	1.84	1.39	21.79	22.04	8	9	1.31	1.08
UML	254.22	254.88	9	8	14.03	8.66	237.72	239.17	9	9	7.34	6.99
UMLD	11.67	12.18	9	8	1.33	0.98	11.47	11.36	9	9	0.91	0.99
UAPD	13.07	13.02	9	8	1.52	1.42	12.98	13.58	9	9	0.91	1.10
FML	430.77	429.38	15	17	22.85	19.95	397.96	395.79	11	12	16.27	16.59
FBL	427.33	424.59	15	17	22.16	19.87	393.77	391.92	11	12	16.39	15.59
FEB	78.19	79.24	16	17	4.23	4.12	71.50	70.75	11	12	3.40	3.45
FAB	67.74	68.55	16	17	3.93	4.07	61.95	61.73	11	12	2.63	3.62
FHD	43.81	43.84	18	17	2.56	2.55	38.99	38.79	11	12	1.32	1.26
FMLD	24.44	24.37	15	17	2.30	1.45	23.38	22.70	11	12	1.34	1.90
FAPD	28.20	27.79	15	17	1.99	2.30	25.86	25.58	11	12	1.53	1.69
TML	366.84	368.88	16	17	20.06	20.24	338.25	337.59	10	11	16.32	17.04
TFL	363.20	365.21	16	17	19.67	19.84	333.94	333.77	10	11	15.88	15.39
TPB	73.11	72.94	14	18	4.02	4.35	66.60	67.14	10	11	2.70	3.26
TPAB	70.69	71.41	10	13	4.28	4.11	64.89	66.12	9	10	2.65	2.83
TMLD	21.69	23.00	16	17	1.97	2.18	20.74	20.89	10	11	2.25	1.57
TAPD	28.08	27.40	16	17	2.80	1.79	23.91	24.95	10	11	1.30	1.55
FIML	353.09	352.33	11	12	18.88	19.18	326.45	328.65	10	10	16.62	14.94
BIB	265.59		16		16.35		262.54		12		11.80	
IBL	149.00	149.60	16	15	7.41	6.85	142.67	141.64	12	11	6.60	5.95
ACH	49.62	49.15	17	17	2.33	2.24	44.27	44.14	12	11	1.27	1.41
TCH	63.90	65.56	10	9	3.57	3.35	60.00	59.71	8	7	4.46	4.42
TTB	29.87	29.43	10	10	1.85	1.51	26.79	27.03	8	8	1.55	2.24

CARTER RANCH

Dimension	MALES						FEMALES					
	Mean		n	Std. Dev.		Mean		n	Std. Dev.			
	left	right		left	right	left	right		left	right		
BBH	142.78		9	4.15		135.57		7	8.64			
GBL	166.00		8	6.48		155.33		6	6.56			
EUB	145.33		9	7.37		141.50		4	8.96			
UFH	82.54		9	5.09		74.95		6	3.42			
NAH	28.30		9	1.89		25.16		7	2.26			
NAW	23.35		9	1.08		23.32		7	0.80			
ZYG	133.44		9	4.93		122.67		6	6.53			
JNB	26.51		7	2.47		21.35		2	0.78			
CML	149.75	148.43	8	7	5.92	7.21	127.10	125.38	5	4	3.58	2.06
CAPD	11.27	11.07	8	7	1.01	0.88	8.91	9.03	5	4	0.88	0.68
CSID	9.48	9.83	8	7	0.77	0.93	7.34	7.58	5	4	0.47	0.45
C1	11.32		7	0.82		10.06		5	1.40			
XC2	35.06		7	1.00		32.70		4	2.71			
XC3	12.97		7	1.19		11.54		4	0.78			
XC4	12.78		6	1.20		10.97		3	0.89			
XC5	12.36		6	1.12		11.29		3	0.54			
XC6	12.92		6	0.98		11.68		4	0.97			
XC7	13.97		6	0.83		12.65		4	0.60			
XT1	16.22		7	0.66		14.22		5	0.53			
XT2	18.12		7	0.82		15.63		5	0.78			
XT3	17.77		7	0.70		15.93		4	0.70			
XT4	18.78		7	0.98		16.62		4	0.70			
XT5	19.20		7	1.05		16.20		5	1.85			
XT6	19.26		7	1.05		16.84		5	1.06			
XT7	20.63		7	0.81		17.65		5	0.90			
XT8	20.79		7	0.90		18.50		5	0.84			
XT9	21.60		7	0.76		18.81		4	1.46			
XT10	22.26		7	1.21		19.75		4	1.25			
XT11	23.01		7	1.48		20.60		4	0.98			
XT12	24.58		7	0.97		22.03		4	1.40			
XL1	26.11		7	0.54		24.06		4	1.01			
XL2	26.18		7	1.67		25.18		4	1.28			
XL3	27.02		7	2.03		24.80		5	1.30			
XL4	27.64		7	1.79		25.52		5	1.10			

CARTER RANCH, CONTINUED

Dimension	MALES						FEMALES					
	Mean		n	Std. Dev.		Mean		n	Std. Dev.			
	left	right		left	right	left	right		left	right		
XL5	28.35		7	1.62		25.80		5	1.31			
S1	30.31		8	1.61		27.43		3	0.86			
SML	106.92		5	13.76		86.34		2	11.89			
HML	313.19	317.25	8	8	10.42	11.63	262.00	276.63	5	4	8.97	18.19
HEB	58.89	59.75	9	8	2.18	1.85	50.33	51.38	6	4	2.79	3.20
HHD	43.67	43.76	7	8	2.36	1.84	35.06	35.51	4	5	1.63	2.42
HMLD	21.01	20.88	8	8	1.66	1.65	18.32	18.97	5	4	0.77	0.68
HAPD	19.03	20.43	8	8	0.91	1.53	16.45	17.44	5	4	0.83	0.68
HAB	41.10	40.34	9	8	1.05	1.07	35.27	36.41	7	4	2.37	2.87
RML	246.25	244.43	8	7	8.01	8.31	205.67	209.58	6	6	6.74	9.63
RMLD	13.49	13.97	8	7	1.27	1.18	12.61	13.10	6	6	1.46	1.12
RAPD	10.99	11.42	8	7	0.31	0.64	9.62	9.83	6	6	0.63	0.74
RMLH	20.11	20.39	8	9	.90	1.00	17.40	18.25	6	6	1.24	1.85
RAPH	20.66	20.83	8	9	1.08	1.04	18.37	18.79	6	6	1.27	1.78
RAB	24.56	24.69	7	9	1.33	1.09	21.06	20.58	6	6	1.12	2.45
UML	263.63	260.50	8	6	9.31	10.86	220.50	221.50	7	5	7.70	10.64
UMLD	12.45	12.78	8	6	0.56	0.50	10.68	11.54	7	5	1.04	0.60
UAPD	14.14	13.28	8	6	1.23	1.33	12.17	12.61	7	5	1.06	1.52
FML	429.44	431.50	8	8	18.51	14.75	382.79	385.17	7	6	23.83	23.54
FBL	426.44	428.44	8	8	17.50	14.86	378.93	381.25	7	6	22.48	23.08
FEB	78.13	78.50	8	8	2.63	2.15	68.80	69.50	5	2	6.17	4.95
FAB	67.86	68.50	8	8	2.96	2.55	58.34	58.32	5	4	5.12	5.53
FHD	44.47	44.14	8	8	1.85	1.56	36.90	37.63	7	6	2.11	2.25
FMLD	24.69	24.27	8	8	1.52	1.94	21.28	22.18	7	6	0.73	1.97
FAPD	27.80	28.17	8	8	1.78	2.00	24.10	24.52	7	6	1.03	1.33
TML	369.13	371.06	8	8	12.01	12.06	317.75	317.21	6	7	16.89	16.68
TFL	366.00	366.69	8	8	12.13	13.02	314.75	313.07	6	7	16.48	16.98
TPB	73.56	73.50	8	8	3.10	2.79	62.17	61.50	6	6	4.42	4.80
TPAB	71.51	72.13	8	8	1.78	2.83	60.71	60.35	6	6	3.23	4.79
TMLD	22.10	24.01	8	8	1.64	1.78	18.82	19.15	6	7	0.75	1.50
TAPD	27.50	26.95	8	8	1.54	1.25	23.83	22.66	6	7	1.67	1.48
FIML	362.40	358.50	5	6	15.29	14.90	317.25	302.50	6	4	33.46	9.68
BIB	270.64		7		12.56		254.33		3		19.35	
IBL	154.20	150.75	5	4	8.53	5.06	135.50	136.50	2	2	2.12	4.95
ACH	49.49	48.13	7	8	1.55	1.67	43.69	43.53	3	3	3.66	3.06
TCH	65.17	63.88	3	4	1.61	3.33	53.80	55.50	5	4	5.08	5.61
TTB	29.11	29.73	4	3	1.20	0.65	26.08	26.50	5	4	1.55	2.10

GRASSHOPPER

Dimension	MALES						FEMALES					
	Mean		n	Std. Dev.		Mean		n	Std. Dev.			
	left	right		left	right	left	right		left	right		
BBH	141.60		25	5.50		135.42		19	7.32			
GBL	160.50		26	8.23		156.81		21	5.13			
EUB	144.92		26	7.91		139.52		21	7.30			
UFH	79.03		24	4.54		76.35		18	5.64			
NAH	26.89		15	2.34		26.04		14	1.30			
NAW	24.68		26	1.69		23.89		21	1.29			
ZYG	138.56		25	8.28		130.40		20	6.24			
JNB	26.52		16	3.61		23.78		15	2.73			
CML	150.63	149.82	24	25	9.73	10.59	135.52	133.90	21	20	7.13	6.63
CAPD	10.32	10.58	24	25	1.12	1.02	8.63	8.98	21	20	0.90	0.93
CSID	9.40	9.48	24	25	1.04	1.02	7.90	7.78	21	20	0.99	0.94
C1	11.13		27	0.96		9.62		20	1.11			
XC2	36.07		27	2.31		33.11		20	2.29			
XC3	13.18		27	1.23		11.27		20	1.05			
XC4	12.70		27	1.04		11.29		21	0.76			
XC5	12.42		27	1.01		11.20		21	0.70			
XC6	12.90		27	1.05		11.58		21	0.78			
XC7	14.22		27	1.29		12.79		21	0.92			
XT1	16.04		26	1.14		14.86		21	1.01			
XT2	17.70		27	1.12		15.98		21	0.97			
XT3	17.87		27	1.18		16.08		21	1.22			
XT4	18.34		27	1.09		16.70		21	0.83			
XT5	18.71		27	0.95		17.09		21	0.92			
XT6	19.43		27	1.02		17.93		21	0.65			
XT7	19.85		27	1.04		18.25		21	0.92			
XT8	20.43		27	1.24		18.79		21	0.81			
XT9	20.99		27	1.22		19.45		21	0.89			
XT10	21.78		27	1.35		20.17		21	0.80			
XT11	22.18		27	1.33		20.89		21	0.88			
XT12	23.87		27	1.28		22.69		21	0.86			
XL1	25.30		27	1.35		24.39		21	1.25			
XL2	26.31		27	1.49		25.34		21	1.06			
XL3	26.73		27	1.94		25.75		21	1.35			
XL4	27.68		27	1.91		26.71		21	1.34			

GRASSHOPPER, CONTINUED

Dimension	MALES						FEMALES					
	Mean		<i>n</i>		Std. Dev.		Mean		<i>n</i>		Std. Dev.	
	left	right			left	right	left	right			left	right
XL5	28.49		27		1.18		27.58		21		1.68	
S1	29.78		27		1.82		28.48		21		2.20	
SML	106.77		16		9.80		103.90		14		6.90	
HML	313.65	316.60	26	25	17.62	16.07	287.50	291.07	21	21	12.80	13.23
HEB	57.42	58.24	26	27	2.92	3.41	51.45	52.70	21	20	2.40	2.55
HHD	43.02	43.30	25	25	2.96	2.68	38.35	39.04	20	21	1.82	2.08
HMLD	20.13	20.71	27	26	1.52	1.72	18.48	19.55	21	20	1.55	1.85
HAPD	18.73	19.57	27	26	1.34	1.34	17.08	17.38	21	20	1.54	1.59
HAB	40.91	40.60	26	27	1.99	2.08	37.53	37.49	21	21	1.98	1.90
RML	244.94	246.64	25	26	12.15	12.71	221.84	224.20	19	20	10.09	10.56
RMLD	13.18	13.76	26	26	1.00	1.11	11.99	12.74	20	20	1.06	1.57
RAPD	10.89	11.21	26	26	0.79	0.84	9.92	10.04	20	20	0.77	0.70
RMLH	20.39	20.82	25	25	1.23	1.26	18.37	18.94	21	19	1.17	1.27
RAPH	21.21	21.37	25	25	1.33	1.31	19.06	19.45	20	19	1.25	1.16
RAB	24.53	24.84	26	26	1.71	1.72	22.43	22.37	19	20	0.88	1.20
UML	260.08	261.46	25	24	13.08	12.47	239.45	240.32	19	19	10.94	11.40
UMLD	11.99	12.11	25	25	0.76	0.84	10.71	10.81	20	19	1.00	0.96
UAPD	13.44	14.00	25	25	1.12	1.52	12.03	12.65	20	19	1.19	1.20
FML	433.60	432.94	26	26	21.78	21.55	405.48	403.62	21	21	18.42	19.54
FBL	430.02	429.71	26	26	22.17	21.41	401.60	399.62	21	21	18.31	18.87
FEB	77.50	77.38	26	25	3.96	4.16	70.58	70.47	18	19	3.74	3.31
FAB	69.39	69.55	26	26	4.66	4.67	62.11	62.25	20	21	3.13	3.22
FHD	43.12	43.29	27	27	2.57	2.59	39.22	39.28	21	21	2.02	1.87
FMLD	24.42	24.50	25	27	1.15	1.72	22.96	22.90	21	21	1.46	1.67
FAPD	28.60	28.51	25	27	2.75	2.78	25.05	25.23	21	21	2.01	2.35
TML	371.28	370.37	25	26	20.54	19.68	341.45	341.43	19	21	15.42	15.71
TFL	366.88	366.90	25	26	20.85	20.08	336.82	337.24	19	21	16.00	15.78
TPB	72.92	72.96	25	24	4.61	4.83	66.08	66.47	18	19	3.22	3.78
TPAB	71.12	70.93	25	24	4.17	4.36	64.19	64.17	18	19	3.05	3.34
TMLD	21.00	22.75	25	27	1.41	1.67	18.29	19.96	21	21	1.43	1.78
TAPD	26.96	26.59	25	27	2.80	2.13	23.45	23.13	21	21	1.74	1.98
FIML	358.81	357.92	18	19	19.95	19.34	326.75	327.21	16	12	15.86	14.21
BIB	264.69		21		9.97		256.63		20		16.99	
IBL	149.50	149.75	18	20	7.78	7.92	140.17	140.44	18	16	6.91	7.38
ACH	48.02	47.99	24	25	2.44	2.68	44.62	43.76	20	20	2.62	2.49
TCH	62.92	63.46	25	26	4.53	3.92	57.23	57.72	20	18	3.22	3.63
TTB	29.47	29.83	24	27	1.88	1.74	27.00	27.09	20	19	1.54	1.65

KNISHBA

Dimension	MALES					FEMALES						
	Mean		n	Std. Dev.		Mean		n	Std. Dev.			
	left	right		left	right	left	right		left	right		
BBH	140.00		6	1.90		136.80		5	5.17			
GBL	154.75		4	8.66		152.80		5	8.87			
EUB	140.60		5	6.47		139.25		4	8.42			
UFH	79.36		6	5.36		74.53		6	3.66			
NAH	25.64		6	3.03		25.42		6	1.94			
NAW	23.51		7	2.05		24.12		6	1.49			
ZYG	136.00		5	6.60		127.86		7	6.82			
JNB	26.60		4	4.43		23.70		6	2.68			
CML	144.72	145.88	9	8	8.76	8.15	135.17	134.67	9	6	7.87	10.21
CAPD	10.27	10.81	9	8	0.77	0.95	8.62	8.94	9	6	0.62	0.80
CSID	8.75	9.06	9	8	0.95	1.00	7.27	7.88	9	6	0.44	0.86
C1	10.70		6	1.37		9.93		10	1.09			
XC2	35.10		6	2.43		31.41		9	1.15			
XC3	12.12		6	1.33		11.83		9	0.81			
XC4	12.17		8	0.62		11.65		5	0.87			
XC5	11.99		7	0.85		11.81		6	0.23			
XC6	12.05		8	0.67		12.13		8	0.78			
XC7	13.52		7	0.49		13.13		8	0.58			
XT1	15.58		6	0.72		14.71		5	0.45			
XT2	17.38		7	0.65		16.12		6	0.33			
XT3	16.82		7	0.56		16.63		6	0.37			
XT4	17.11		7	0.78		16.97		6	0.63			
XT5	17.67		7	1.15		17.13		5	0.81			
XT6	18.61		7	0.94		17.35		4	1.00			
XT7	19.01		7	0.81		17.97		5	1.19			
XT8	19.79		7	1.09		18.35		6	0.90			
XT9	20.43		8	0.95		18.98		6	0.84			
XT10	20.29		9	1.18		19.92		7	0.80			
XT11	20.94		8	0.94		20.53		7	0.70			
XT12	22.80		8	1.19		22.49		6	0.66			
XL1	24.53		9	1.23		23.59		7	1.25			
XL2	25.26		9	0.87		24.51		8	1.36			
XL3	25.92		9	1.12		25.24		8	1.04			
XL4	26.64		10	1.07		26.10		8	1.25			

KNISHBA, CONTINUED

Dimension	MALES						FEMALES					
	Mean		<i>n</i>		Std. Dev.		Mean		<i>n</i>		Std. Dev.	
	left	right			left	right	left	right			left	right
XL5	27.36		10		1.53		27.32		8		1.17	
S1	29.39		4		1.63		28.55		7		2.69	
SML	102.84		4		12.29		100.52		6		10.91	
HML	308.39	309.30	9	10	18.47	19.73	288.46	290.31	11	8	9.89	11.35
HEB	55.45	57.30	10	10	4.76	4.27	52.09	53.25	11	8	2.81	2.75
HHD	42.03	43.20	8	10	4.03	3.55	38.45	38.77	11	8	1.75	2.07
HMLD	19.39	19.94	10	10	1.30	1.53	18.34	18.65	11	9	1.36	1.42
HAPD	18.30	19.14	10	10	0.91	1.13	17.06	17.19	11	9	1.64	1.45
HAB	39.17	40.05	10	10	2.50	2.55	37.19	37.04	11	8	1.50	1.26
RML	239.88	242.30	12	10	16.91	18.92	221.86	224.10	11	10	13.09	11.87
RMLD	13.47	13.46	12	10	0.92	1.01	12.15	12.53	11	10	1.30	1.12
RAPD	10.97	11.15	12	10	0.96	0.81	9.42	9.79	11	10	0.78	0.75
RMLH	20.10	20.48	13	10	1.55	1.38	18.72	19.23	12	9	1.16	0.73
RAPH	20.92	20.86	13	10	1.65	1.78	19.72	19.55	12	9	1.42	0.89
RAB	24.18	23.62	12	10	2.17	2.08	22.53	22.57	11	10	1.02	.75
UML	257.23	258.70	11	10	17.54	18.20	238.75	241.05	10	10	11.84	9.81
UMLD	11.86	12.32	11	10	0.98	0.95	10.46	10.31	10	10	0.79	0.61
UAPD	13.82	13.60	11	10	1.21	1.17	11.65	12.71	10	10	0.85	1.78
FML	427.08	429.77	12	11	25.81	29.25	399.91	397.45	11	10	14.31	13.52
FBL	423.79	426.59	12	11	25.66	29.81	395.55	395.94	10	9	14.96	12.27
FEB	76.33	77.09	12	11	5.81	5.96	71.44	71.63	9	12	2.59	2.83
FAB	66.93	67.15	12	11	5.60	5.84	62.00	61.90	9	12	4.26	3.26
FHD	42.34	42.75	12	11	3.26	3.42	38.89	39.09	10	12	1.75	1.64
FMLD	24.70	25.05	12	11	1.79	1.75	22.96	22.67	11	11	1.79	2.11
FAPD	28.00	27.92	12	11	2.80	2.77	25.03	24.78	11	11	1.76	1.61
TML	370.67	363.25	9	8	31.74	26.49	343.85	342.05	10	10	14.17	16.58
TFL	366.97	358.95	9	8	31.95	26.89	339.75	338.55	10	10	14.23	15.93
TPB	71.63	71.61	8	9	4.51	3.59	66.59	66.06	11	9	2.67	2.55
TPAB	69.27	69.52	8	9	4.74	3.96	64.72	64.20	11	9	2.68	2.68
TMLD	21.22	22.19	9	9	1.39	1.87	18.45	19.00	11	11	1.67	1.47
TAPD	25.87	26.48	9	9	2.08	2.16	23.07	23.19	11	11	1.61	1.26
FIML	357.28	353.36	9	7	25.85	17.36	328.75	328.30	6	10	10.76	11.93
BIB	269.00		2		12.73		262.17		6		20.18	
IBL	149.00	146.33	3	3	4.36	10.79	138.40	138.40	5	5	5.13	4.93
ACH	47.77	47.38	2	1	3.46		43.52	43.48	4	6	3.16	2.71
TCH	61.88	61.50	8	5	4.70	4.50	56.69	57.86	8	7	1.62	1.97
TTB	29.55	29.43	8	8	2.30	2.47	26.37	26.64	8	9	1.63	1.60

POINT OF PINES / TURKEY CREEK

Dimension	MALES						FEMALES					
	Mean		n	Std. Dev.		Mean		n	Std. Dev.			
	left	right		left	right	left	right		left	right		
BBH	141.33		6	4.72		135.00		5	5.24			
GBL	163.17		6	7.70		156.60		5	5.68			
EUB	139.00		6	9.53		141.20		5	4.76			
UFH	82.71		6	4.23		78.14		5	3.63			
NAH	28.16		5	2.89		26.11		2	0.64			
NAW	25.52		7	1.76		25.70		5	2.41			
ZYG	135.50		6	7.34		132.80		5	9.12			
JNB	27.00		3	3.57		21.62		3	2.58			
CML	145.83	148.63	6	4	4.60	5.50	134.00	133.42	5	6	3.45	6.41
CAPD	10.17	10.78	6	4	0.59	1.35	9.43	9.67	5	6	0.56	0.59
CSID	8.46	9.46	6	4	0.90	1.48	7.71	8.28	5	6	0.53	0.82
C1	10.27		7	0.90		10.08		5	1.44			
XC2	37.03		7	3.58		33.23		4	1.30			
XC3	12.97		7	1.23		11.43		4	0.38			
XC4	12.10		7	0.64		11.05		3	0.48			
XC5	11.42		7	0.55		10.76		3	0.62			
XC6	12.16		8	0.93		11.15		5	0.39			
XC7	13.80		8	0.94		12.72		5	0.71			
XT1	16.03		8	0.92		13.92		5	0.70			
XT2	17.70		8	0.69		15.43		6	0.99			
XT3	17.54		8	0.71		15.86		5	0.69			
XT4	17.87		8	0.91		16.06		5	0.46			
XT5	18.90		7	0.99		16.73		6	0.68			
XT6	19.58		7	1.18		17.15		6	0.61			
XT7	19.76		8	1.29		17.42		6	0.41			
XT8	20.24		8	1.16		18.58		7	0.91			
XT9	20.79		8	1.33		17.96		6	2.40			
XT10	21.35		8	0.84		18.79		5	2.10			
XT11	22.02		8	0.66		20.59		5	0.80			
XT12	23.84		8	1.26		20.88		5	2.19			
XL1	25.32		8	1.30		22.78		6	1.44			
XL2	25.71		7	1.37		23.33		6	1.70			
XL3	26.74		7	1.45		24.43		6	1.19			
XL4	27.58		7	1.47		24.90		6	0.94			

POINT OF PINES / TURKEY CREEK, CONTINUED

Dimension	MALES						FEMALES					
	Mean		n	Std. Dev.		Mean		n	Std. Dev.			
	left	right		left	right	left	right		left	right		
XL5	28.52		8	1.30		25.74		6	1.33			
S1	28.89		8	2.38		29.17		8	1.56			
SML	107.42		5	2.55		101.17		6	9.80			
HML	310.61	310.50	9	9	12.84	13.64	284.61	291.50	9	7	12.63	13.21
HEB	57.28	57.56	9	9	2.79	2.36	52.50	53.50	9	8	2.38	2.05
HHD	42.92	43.85	9	9	2.75	1.92	38.03	38.44	9	8	1.21	0.89
HMLD	19.83	19.86	9	9	1.34	1.57	18.57	18.55	9	9	1.44	1.45
HAPD	18.20	19.47	9	9	1.11	0.99	17.10	17.85	9	9	1.51	1.58
HAB	40.29	40.08	9	9	1.72	1.63	37.22	37.81	9	9	2.05	1.76
RML	240.78	244.00	9	7	10.67	12.24	221.86	224.00	7	9	10.59	11.17
RMLD	13.21	14.04	9	7	1.13	1.27	11.84	12.42	7	9	1.63	1.39
RAPD	10.95	11.27	9	7	0.69	0.68	9.69	9.82	7	9	0.90	0.77
RMLH	20.21	20.19	9	7	1.11	0.92	18.48	19.31	9	8	0.64	0.68
RAPH	20.72	20.83	9	7	0.82	0.87	19.19	19.72	9	9	0.56	0.61
RAB	23.77	23.88	9	7	1.62	1.54	21.99	22.38	8	9	1.34	1.19
UML	257.22	258.25	9	6	9.99	13.34	239.63	239.50	8	8	9.78	11.39
UMLD	11.87	12.50	9	6	1.22	0.76	11.23	10.83	8	8	1.22	0.55
UAPD	13.22	13.79	9	6	1.48	1.28	12.21	12.52	8	8	1.46	1.44
FML	429.33	428.06	9	9	21.38	20.69	395.31	394.78	8	9	18.66	17.27
FBL	426.67	425.72	9	9	21.45	21.21	392.81	393.75	8	8	17.89	16.08
FEB	75.75	75.69	8	8	3.72	3.46	70.44	69.94	9	8	2.99	3.10
FAB	68.29	68.19	9	9	4.30	3.89	61.36	60.24	9	8	2.53	2.88
FHD	42.90	42.88	9	9	2.57	2.49	38.98	38.92	8	9	2.07	2.02
FMLD	24.31	24.28	9	9	2.13	1.42	23.04	22.99	8	9	1.48	1.18
FAPD	28.79	28.47	9	9	1.74	1.72	24.54	24.65	8	9	1.45	1.78
TML	366.81	366.17	8	9	21.58	19.49	340.00	340.63	8	8	20.58	18.34
TFL	363.81	363.44	8	9	21.59	19.82	335.63	337.13	8	8	20.36	18.53
TPB	73.25	72.25	6	8	2.84	3.89	66.88	65.94	8	8	2.40	3.45
TPAB	69.84	68.85	8	7	3.94	4.36	64.82	63.65	8	8	2.25	2.41
TMLD	20.78	23.13	9	9	1.65	1.44	17.67	18.94	8	8	1.85	1.26
TAPD	26.92	26.93	9	9	1.31	1.40	23.97	23.80	8	8	1.15	2.59
FIML	347.60	347.00	5	4	25.90	20.38	322.25	320.42	6	6	20.22	20.39
BIB	258.71		7		13.99		253.75		8		15.65	
IBL	144.80	142.60	5	5	5.45	4.72	144.71	141.56	7	9	11.81	10.81
ACH	47.82	46.90	8	8	3.11	2.25	44.43	43.36	9	9	2.27	2.12
TCH	59.20	60.00	5	6	3.70	3.18	55.67	56.50	3	3	2.52	3.12
TTB	29.03	29.46	6	6	1.64	1.42	26.79	27.18	3	4	2.38	1.93

SAINT FRANCIS AND BLACK RIVERS

Dimension	MALES						FEMALES					
	Mean		n	Std. Dev.		Mean		n	Std. Dev.			
	left	right		left	right	left	right		left	right		
BBH	145.33		3	7.02		136.57		7	3.99			
GBL	170.67		3	4.51		166.00		7	4.47			
EUB	141.00		3	5.57		137.00		7	5.86			
UFH	84.37		3	4.75		79.94		6	4.13			
NAH	29.73		3	1.83		30.04		6	2.64			
NAW	25.33		3	2.16		25.73		6	1.30			
ZYG	140.67		3	6.11		130.71		7	8.38			
JNB	29.39		3	5.45		22.35		2	1.68			
CML	157.00	154.95	11	10	6.39	6.58	146.75	143.17	8	9	6.71	7.26
CAPD	12.04	11.56	11	10	1.48	0.68	9.94	10.42	8	10	0.96	0.72
CSID	10.68	10.42	11	10	1.07	1.02	8.28	8.67	8	10	0.89	1.00
C1	12.36		1			10.06		4	1.80			
XC2	41.08		2	6.94		36.80		4	1.98			
XC3	15.79		2	0.27		12.46		4	0.37			
XC4	15.00		2	0.22		11.46		4	0.42			
XC5	14.62		2	0.13		11.38		4	0.27			
XC6	13.44		3	1.22		11.52		5	0.26			
XC7	13.56		2	0.09		13.01		4	0.19			
XT1	16.93		2	2.55		15.06		4	0.85			
XT2	18.81		2	1.20		16.77		4	1.35			
XT3	18.55		2	0.05		17.40		4	0.46			
XT4	18.43		1			17.70		4	0.71			
XT5	19.18		1			18.15		4	0.62			
XT6	20.42		1			19.48		4	0.45			
XT7	21.39		1			19.20		4	0.39			
XT8	21.59		2	0.03		20.10		4	0.88			
XT9	22.25		2	0.35		20.52		4	0.88			
XT10	40.08		3	0.13		21.80		4	0.97			
XT11	23.35		2	1.16		22.44		4	0.66			
XT12	24.57		2	0.34		24.22		4	0.51			
XL1	26.52		3	0.65		26.06		4	0.18			
XL2	26.93		2	0.65		26.09		4	0.38			
XL3	28.19		3	0.72		27.08		5	0.39			
XL4	29.10		3	0.80		27.32		5	0.98			

SAINT FRANCIS AND BLACK RIVERS, CONTINUED

Dimension	MALES						FEMALES					
	Mean		n		Std. Dev.		Mean		n		Std. Dev.	
	left	right			left	right	left	right			left	right
XL5	30.35		3		1.40		27.61		5		2.16	
S1	33.64		11		1.70		31.58		8		2.54	
SML	112.21		7		7.45		104.14		8		6.13	
HML	334.00	334.55	11	10	18.86	18.71	307.18	311.45	11	10	7.57	8.73
HEB	62.05	62.55	11	10	2.92	3.27	54.65	55.27	10	11	3.89	3.80
HHD	46.10	46.70	11	10	3.24	3.50	40.80	41.46	11	11	2.35	2.90
HMLD	22.82	22.30	11	10	1.52	1.73	18.92	18.75	11	10	2.19	2.02
HAPD	21.76	22.74	11	10	1.56	1.98	19.68	20.14	11	10	2.44	2.27
HAB	43.79	44.50	11	10	2.12	1.69	38.88	39.44	10	11	1.89	2.10
RML	257.11	263.55	9	10	16.98	14.24	238.65	242.22	10	9	10.94	9.49
RMLD	14.74	14.92	10	10	1.54	1.13	13.63	14.07	9	8	1.82	1.73
RAPD	12.90	12.57	10	10	1.29	1.18	10.95	11.11	9	8	0.90	0.98
RMLH	21.99	22.25	9	10	1.45	1.39	19.74	19.76	9	10	1.26	1.03
RAPH	22.75	22.90	9	10	1.60	1.35	20.59	20.41	9	10	1.42	0.87
RAB	26.50	26.79	9	10	1.45	1.41	24.46	24.29	10	9	.76	1.15
UML	276.45	283.93	10	7	15.62	15.66	256.17	259.55	9	10	8.33	8.95
UMLD	13.16	13.79	11	9	1.56	1.32	11.52	11.93	10	9	1.20	0.94
UAPD	15.42	15.43	11	9	1.55	1.33	14.66	14.18	10	9	2.36	1.43
FML	455.17	462.59	9	11	20.07	24.22	431.18	429.55	11	10	10.34	11.57
FBL	452.33	458.23	9	11	19.62	23.76	426.36	423.44	11	9	10.83	11.35
FEB	79.38	81.05	8	11	3.13	3.14	73.86	74.14	11	7	3.25	3.73
FAB	69.39	70.60	8	11	3.40	2.83	63.99	64.15	10	7	3.15	4.05
FHD	46.60	46.90	10	11	2.93	2.98	41.34	41.30	11	10	1.78	1.66
FMLD	26.80	27.27	9	11	1.00	1.08	24.86	24.36	11	10	1.76	1.92
FAPD	29.38	29.92	9	11	2.38	2.22	26.66	26.86	11	10	1.87	1.49
TML	390.22	393.72	9	9	23.33	20.84	357.20	356.70	10	10	13.15	11.80
TFL	385.08	389.22	9	9	22.99	21.01	352.85	352.70	10	10	13.07	11.17
TPB	75.63	75.56	8	8	4.08	3.87	68.30	67.95	10	10	3.34	3.44
TPAB	72.86	72.36	8	8	4.44	3.60	65.90	65.69	10	10	3.04	3.32
TMLD	22.77	24.58	9	9	2.12	2.03	20.58	22.94	10	10	2.13	1.65
TAPD	31.08	29.90	9	9	1.99	2.88	27.09	26.73	10	10	2.15	1.89
FIML	380.50	370.20	3	5	12.13	23.18	339.94	340.50	8	6	11.94	11.29
BIB	284.32		11		16.18		266.75		8		9.77	
IBL	156.40	156.43	10	7	10.23	11.25	150.86	149.86	7	7	5.34	5.98
ACH	51.61	51.13	11	9	2.29	2.96	46.52	45.20	10	10	2.21	2.33
TCH	63.21	64.71	7	7	2.46	2.77	58.00	58.17	5	6	3.69	2.77
TTB	29.71	29.31	7	8	1.47	1.21	27.59	27.77	6	6	1.48	1.58

BEAR CREEK / JONES SITES

Dimension	MALES						FEMALES					
	Mean		n	Std. Dev.		Mean		n	Std. Dev.			
	left	right		left	right	left	right		left	right		
BBH	142.00		8	3.07		136.33		9	3.12			
GBL	182.75		8	5.85		177.11		9	4.91			
EUB	141.75		8	2.92		135.00		9	3.61			
UFH	82.83		6	4.45		75.27		7	3.82			
NAH	31.56		3	4.22		26.09		7	2.14			
NAW	23.80		10	1.71		24.93		7	1.99			
ZYG	144.25		8	3.06		133.13		8	4.91			
JNB	31.23		4	6.23		25.10		1				
CML	153.72	152.89	9	9	6.07	6.68	140.30	137.61	5	9	9.22	6.79
CAPD	11.15	11.68	9	9	0.54	0.33	10.50	10.36	5	9	0.73	0.98
CSID	10.02	10.28	9	9	1.24	1.44	8.92	9.30	5	9	0.92	1.02
C1	11.12		10	1.06		9.76		8	0.80			
XC2	11.12		10	1.06		34.55		9	2.30			
XC3	37.14		14	3.16		11.86		9	1.09			
XC4	12.79		14	1.13		11.73		6	0.92			
XC5	13.37		10	1.11		11.11		7	1.20			
XC6	12.74		10	1.41		11.48		9	0.54			
XC7	13.27		7	1.02		13.16		8	0.71			
XT1	14.55		8	1.42		15.22		8	0.74			
XT2	17.44		9	0.57		17.21		7	0.95			
XT3	19.25		12	1.24		17.94		7	0.97			
XT4	19.33		9	1.37		18.02		7	1.07			
XT5	20.08		7	0.94		19.00		8	1.10			
XT6	20.64		8	1.28		19.65		7	1.15			
XT7	21.24		8	1.23		20.02		8	0.54			
XT8	21.66		8	1.42		20.79		9	0.74			
XT9	22.10		10	1.55		21.15		10	0.99			
XT10	22.50		12	1.28		21.55		10	0.87			
XT11	23.53		12	1.50		22.08		10	0.94			
XT12	24.22		13	1.04		24.22		10	1.24			
XL1	25.58		14	1.01		25.84		11	1.62			
XL2	27.03		15	1.61		26.62		11	1.59			
XL3	27.44		13	1.32		27.20		11	1.67			
XL4	27.79		13	1.38		27.80		11	1.71			

BEAR CREEK / JONES SITES, CONTINUED

Dimension	MALES						FEMALES					
	Mean		n		Std. Dev.		Mean		n		Std. Dev.	
	left	right			left	right	left	right			left	right
XL5	28.98		14		1.35		28.26		11		2.37	
S1	30.68		12		2.17		29.17		8		1.69	
SML	128.30		5		13.27		108.95		6		9.37	
HML	327.63	322.89	8	13	15.32	14.03	307.13	309.39	8	9	12.63	11.76
HEB	60.80	60.65	10	13	3.90	3.24	54.17	56.40	9	10	2.44	3.91
HHD	46.81	46.90	10	13	2.78	2.47	41.14	41.95	10	10	1.60	2.83
HMLD	20.79	20.84	11	13	1.22	1.42	18.11	18.28	10	10	1.36	1.27
HAPD	20.21	21.33	11	13	1.44	1.26	17.50	19.32	10	10	1.66	1.56
HAB	45.58	45.11	9	12	2.67	2.34	39.36	39.58	9	10	2.03	2.86
RML	254.56	255.00	9	12	12.61	13.21	232.29	232.50	7	10	6.63	7.62
RMLD	14.00	14.29	11	12	1.38	.94	12.81	13.11	7	11	0.64	0.94
RAPD	11.88	11.95	11	12	.83	.71	10.73	10.53	7	11	0.48	0.83
RMLH	22.03	22.23	12	11	1.45	1.54	19.98	20.13	7	12	1.17	1.10
RAPH	22.89	22.62	12	11	1.64	1.50	20.48	20.40	7	12	1.20	1.25
RAB	26.23	26.73	8	11	1.92	1.93	23.80	23.84	10	9	1.11	1.40
UML	273.67	274.23	12	11	11.72	14.77	255.64	254.15	7	10	7.52	8.51
UMLD	13.04	13.36	12	12	1.09	.82	11.82	11.71	9	10	1.00	1.32
UAPD	14.69	15.33	12	12	1.41	1.73	12.96	13.40	9	10	1.10	1.39
FML	464.21	460.86	12	11	16.94	15.98	422.31	430.92	8	6	13.76	19.13
FBL	460.63	455.86	12	11	16.37	15.89	420.14	426.75	7	6	14.01	18.92
FEB	82.23	82.31	11	13	3.55	3.76	74.81	74.71	8	7	4.73	4.81
FAB	71.96	73.16	11	12	4.00	4.72	65.20	66.08	9	8	3.98	4.14
FHD	46.72	47.05	14	11	1.79	1.62	42.99	41.95	7	6	2.82	2.94
FMLD	26.91	26.52	13	13	1.30	1.05	25.46	25.23	9	7	1.25	1.27
FAPD	29.05	28.96	13	13	2.12	1.42	25.49	25.57	9	7	2.02	1.82
TML	384.65	385.65	10	13	15.52	15.75	356.13	365.71	8	7	14.44	12.34
TFL	379.85	381.53	10	13	16.22	16.33	351.99	361.59	8	7	13.79	12.59
TPB	78.54	78.81	12	13	3.35	3.02	70.19	71.00	8	7	4.15	4.05
TPAB	76.51	76.55	12	13	3.38	3.45	68.25	69.37	8	7	4.26	3.92
TMLD	22.17	24.51	12	13	1.51	1.45	19.90	22.41	9	8	1.27	2.15
TAPD	30.67	29.27	12	13	2.80	2.36	26.65	26.47	9	8	1.77	3.07
FIML	378.50	366.14	6	7	18.14	15.65		347.00		2		9.90
BIB	287.28		9		14.95		261.58		6		8.16	
IBL	161.78	162.78	9	9	9.60	9.30	150.33	151.57	6	7	6.68	6.13
ACH	52.26	51.62	12	11	2.02	2.42	46.77	46.36	5	5	2.88	1.87
TCH	66.21	67.00	7	8	4.19	3.13	63.00	59.30	1	5		1.79
TTB	32.22	31.90	9	9	1.57	1.18	28.75	28.83	2	6	1.41	1.58

BLOSSOM (GOLDMAN)

Dimension	MALES						FEMALES					
	Mean		n	Std. Dev.		Mean		n	Std. Dev.			
	left	right		left	right	left	right		left	right		
BBH	143.61		18	4.49		139.53		15	4.72			
GBL	185.89		18	4.95		180.13		15	4.93			
EUB	142.06		18	4.29		136.67		15	4.73			
UFH	84.36		18	4.46		78.45		14	2.81			
NAH	30.79		14	2.54		27.36		9	1.39			
NAW	25.33		18	2.18		23.49		14	1.36			
ZYG	143.28		18	5.09		133.93		15	6.11			
JNB	31.58		11	1.73		29.99		10	3.27			
CML	161.33	155.97	12	17	9.41	10.01	137.90	136.31	15	13	6.90	6.13
CAPD	12.79	13.15	12	17	1.14	1.44	10.53	10.77	15	13	0.93	0.93
CSID	10.12	10.72	12	17	0.44	1.58	8.84	8.96	15	13	0.96	1.14
C1	11.26		16	1.08		10.49		12	1.05			
XC2	36.82		16	2.48		35.01		13	1.39			
XC3	13.53		15	1.12		12.11		13	1.05			
XC4	12.89		16	0.98		11.81		12	0.81			
XC5	12.54		16	0.86		11.56		12	0.73			
XC6	12.51		17	0.65		11.91		13	0.70			
XC7	13.97		15	0.64		13.07		13	1.04			
XT1	16.73		16	1.14		15.52		14	0.76			
XT2	18.61		16	1.12		17.23		14	1.01			
XT3	18.79		16	1.27		17.58		13	0.99			
XT4	19.00		15	1.55		18.43		12	0.79			
XT5	19.77		15	1.50		18.76		12	0.96			
XT6	20.94		16	1.32		19.75		13	1.02			
XT7	21.41		16	1.60		20.39		13	1.29			
XT8	21.62		15	1.35		21.14		12	1.30			
XT9	22.39		15	1.29		21.43		12	1.17			
XT10	23.07		16	1.39		21.84		11	1.18			
XT11	23.61		17	1.46		22.68		11	1.21			
XT12	24.88		17	1.24		24.06		14	1.51			
XL1	26.92		18	1.40		25.81		15	1.38			
XL2	27.21		18	1.39		26.53		13	1.29			
XL3	27.61		17	1.55		27.17		13	1.60			
XL4	28.44		17	1.26		28.04		14	1.99			

BLOSSOM (GOLDMAN), CONTINUED

Dimension	MALES						FEMALES					
	Mean		<i>n</i>		Std. Dev.		Mean		<i>n</i>		Std. Dev.	
	left	right			left	right	left	right			left	right
XL5	29.25		17		1.51		28.92		14		1.60	
S1	31.58		19		2.51		31.28		17		2.43	
SML	118.52		16		15.00		109.89		15		9.19	
HML	324.29	324.97	17	16	15.60	17.39	301.25	305.90	12	15	10.45	10.98
HEB	62.21	61.77	17	15	4.54	4.22	57.06	56.80	16	15	1.93	2.00
HHD	47.63	48.01	17	15	3.20	2.59	43.14	42.85	13	14	1.39	1.55
HMLD	21.46	22.47	18	16	1.61	1.66	19.42	19.53	15	15	1.08	1.25
HAPD	21.40	22.06	18	16	1.82	1.42	19.26	19.45	15	15	1.11	1.31
HAB	45.84	45.86	16	15	2.66	2.85	41.65	40.98	16	15	1.27	1.71
RML	256.06	256.27	18	15	13.96	13.50	230.00	230.64	14	14	9.14	7.73
RMLD	14.86	15.33	19	16	1.21	1.12	13.55	13.76	14	15	0.81	1.22
RAPD	12.18	12.69	19	16	0.90	0.93	11.09	11.07	14	15	0.62	0.78
RMLH	22.48	23.04	19	14	0.97	0.98	20.66	20.60	15	14	1.20	1.16
RAPH	23.49	23.65	19	14	1.03	1.02	21.24	21.30	14	13	1.18	1.15
RAB	26.34	26.91	17	15	1.59	1.50	24.17	24.71	15	15	0.97	1.00
UML	276.69	275.89	18	14	15.13	13.12	250.31	252.18	13	11	9.64	10.22
UMLD	13.38	14.01	18	15	0.98	1.22	12.46	12.86	13	14	0.68	0.91
UAPD	16.02	16.32	18	15	1.19	1.42	13.95	14.29	13	14	1.15	1.10
FML	457.53	455.33	19	15	24.76	24.35	430.94	434.08	18	12	14.70	12.79
FBL	453.68	451.03	19	15	24.73	24.27	425.72	428.17	16	12	15.60	13.58
FEB	83.08	83.20	19	15	4.94	4.80	75.03	75.72	16	18	3.23	3.01
FAB	72.67	72.97	20	15	4.37	4.49	65.38	65.99	17	18	2.39	1.90
FHD	47.35	46.93	20	16	2.77	2.91	42.43	42.16	18	18	2.12	1.86
FMLD	27.21	26.87	19	16	1.81	1.76	25.20	24.97	19	13	1.47	1.27
FAPD	29.28	29.26	19	16	2.10	2.28	24.95	25.62	19	13	1.89	1.46
TML	385.68	379.77	17	17	22.18	20.97	353.86	357.79	18	17	15.14	14.97
TFL	382.62	376.89	17	17	22.38	20.87	350.94	354.79	18	17	15.09	15.68
TPB	78.92	78.72	19	16	4.17	3.72	71.03	71.53	19	18	2.73	2.61
TPAB	77.04	76.87	19	16	3.74	3.41	69.07	69.91	19	18	2.70	2.60
TMLD	21.71	23.25	18	17	1.17	1.48	19.41	20.85	18	19	1.17	1.42
TAPD	30.42	29.56	18	17	1.88	2.17	25.78	24.50	18	19	1.93	1.85
FIML	372.59	374.86	11	11	17.10	15.00	342.57	343.70	14	15	16.33	15.82
BIB	280.38		17		14.06		269.24		17		13.13	
IBL	159.00	158.69	18	16	9.07	8.12	155.33	154.63	15	16	3.29	4.75
ACH	53.44	52.54	19	20	2.69	3.12	47.68	47.45	18	17	2.22	2.58
TCH	70.22	68.64	9	7	3.41	4.37	61.54	62.50	13	13	3.00	2.53
TTB	32.10	31.87	14	9	1.48	1.49	28.80	28.85	13	14	0.76	1.04

NORTHERN CHANNEL ISLANDS

Dimension	MALES						FEMALES					
	Mean		<i>n</i>	Std. Dev.		Mean		<i>n</i>	Std. Dev.			
	left	right		left	right	left	right		left	right		
BBH	129.00		2	1.41		126.00		6	3.74			
GBL	187.00		2	4.24		177.33		6	6.22			
EUB	132.00		2	5.66		138.17		6	3.25			
UFH	82.29		3	4.17		77.49		6	4.33			
NAH	31.11		3	3.52		28.05		6	2.15			
NAW	25.01		3	1.03		23.09		6	1.99			
ZYG	136.67		3	5.77		128.67		6	4.08			
JNB	25.62		2	2.42		25.73		3	1.62			
CML	148.75	148.00	2	3	10.96	5.57	136.60	135.14	5	7	5.28	5.66
CAPD	11.56	12.28	2	3	0.39	0.16	9.24	9.67	5	7	0.34	0.67
CSID	10.04	10.39	2	3	0.16	0.79	8.05	8.03	5	7	1.08	0.80
C1	10.06		1			9.99		3	1.20			
XC2	33.86		3	0.28		32.62		5	1.41			
XC3	11.96		3	0.74		10.99		5	0.91			
XC4	10.88		2	0.60		10.49		5	1.09			
XC5	10.98		2	1.03		10.11		5	1.60			
XC6	10.91		3	0.78		10.43		6	1.27			
XC7	13.02		3	1.41		11.48		6	0.72			
XT1	15.71		2	2.09		13.43		6	1.06			
XT2	16.18		2	1.48		14.70		5	1.32			
XT3	16.85		2	0.43		15.30		5	1.43			
XT4	16.99		3	1.25		15.88		6	1.05			
XT5	18.11		3	0.71		17.05		5	1.07			
XT6	18.42		3	0.64		17.58		5	0.90			
XT7	18.15		3	2.74		18.15		6	0.78			
XT8	18.83		2	2.09		18.50		6	0.68			
XT9	20.04		2	3.13		19.12		5	0.58			
XT10	20.33		2	2.23		19.70		5	0.70			
XT11	20.90		3	2.15		20.02		6	1.04			
XT12	22.31		3	2.01		21.65		6	1.33			
XL1	23.76		3	0.87		23.32		6	1.75			
XL2	24.35		3	2.25		23.46		6	1.33			
XL3	23.92		3	1.63		23.95		6	1.46			
XL4	25.15		3	1.11		24.66		6	1.66			

NORTHERN CHANNEL ISLANDS, CONTINUED

Dimension	MALES						FEMALES					
	Mean		n	Std. Dev.		Mean		n	Std. Dev.			
	left	right		left	right	left	right		left	right		
XL5	25.06		3	1.13		24.64		6	2.58			
S1	27.77		3	1.83		26.18		5	2.06			
SML	114.36		2	5.62		93.99		4	3.92			
HML	312.75	305.00	2	2	1.77	7.78	278.30	280.58	5	6	16.15	15.17
HEB	59.33	58.25	3	2	3.33	4.60	51.00	52.92	6	6	2.66	2.69
HHD	42.47	41.95	3	3	2.10	3.77	38.73	39.08	5	6	1.35	1.24
HMLD	21.96	22.57	3	2	.86	1.54	17.76	18.38	6	6	1.21	1.47
HAPD	21.02	21.33	3	2	3.34	1.39	17.32	18.25	6	6	0.71	2.14
HAB	41.74	41.18	3	2	3.52	1.93	37.99	38.97	6	6	1.90	1.84
RML	239.67	236.00	3	2	11.02	11.31	214.00	218.08	5	6	18.38	17.06
RMLD	14.13	13.44	3	3	1.27	0.61	12.52	13.12	5	6	2.60	3.04
RAPD	12.36	11.64	3	3	.61	1.02	9.52	9.52	5	6	0.29	0.48
RMLH	20.24		2		1.41		19.76	19.63	5	5	0.64	0.53
RAPH	20.85	21.41	2	1	.95		20.30	20.50	5	5	0.88	0.52
RAB	24.11	24.94	3	3	1.41	1.42	23.77	23.58	5	6	1.34	1.02
UML	255.75	268.00	2	1	15.91		236.29	234.60	7	5	16.72	16.80
UMLD	13.11		2		2.28		10.56	10.54	7	6	0.74	0.51
UAPD	15.73		2		3.21		12.35	13.09	7	6	0.93	0.90
FML	427.17	424.50	3	3	19.78	17.67	393.00	390.43	7	7	23.69	23.93
FBL	422.83	421.33	3	3	19.28	18.54	389.00	386.36	7	7	24.35	23.87
FEB	78.50	78.00	3	2	3.50	3.54	70.79	70.79	7	7	2.08	2.67
FAB	70.94	69.16	3	2	1.53	1.82	62.47	64.37	7	7	1.95	2.76
FHD	43.45	43.46	3	3	1.61	1.37	40.07	39.92	7	7	2.27	1.98
FMLD	24.23	24.68	3	3	1.01	1.77	21.92	22.21	7	7	1.66	1.63
FAPD	30.11	30.20	3	3	2.12	2.30	24.97	25.79	7	7	2.27	2.28
TML	358.83	362.50	3	3	16.81	13.44	330.31	326.71	8	7	22.55	22.47
TFL	356.50	360.33	3	3	16.04	12.42	327.75	323.57	8	7	23.04	23.02
TPB	74.67	75.00	3	3	1.53	2.65	67.94	69.00	8	6	2.78	2.70
TPAB	71.59	73.75	3	3	2.03	2.30	66.45	67.59	8	6	2.83	1.84
TMLD	21.44	23.30	3	3	2.58	1.50	18.13	19.66	8	7	1.24	1.35
TAPD	29.32	27.64	3	3	3.09	2.99	24.77	24.08	8	7	0.93	0.84
FIML	340.00	347.50	2	3	21.21	20.61	306.30	306.20	5	5	22.71	22.42
BIB	248.33		3		9.71		253.21		7		21.35	
IBL	139.00	146.00	1	3		6.00	144.86	140.67	7	6	6.26	7.03
ACH	48.36	47.98	3	3	1.15	1.66	45.60	44.91	7	6	1.91	2.99
TCH	61.75	63.33	2	3	4.60	2.52	58.50	59.10	6	5	2.59	2.46
TTB	27.77	28.11	3	3	1.39	1.10	26.80	27.04	5	5	0.93	0.74

SAN NICHOLAS ISLAND

Dimension	MALES						FEMALES					
	Mean		n	Std. Dev.		Mean		n	Std. Dev.			
	left	right		left	right	left	right		left	right		
BBH	129.80		5	5.07		122.00		5	1.58			
GBL	183.00		5	3.74		180.00		5	7.84			
EUB	140.20		5	5.45		136.00		5	5.79			
UFH	79.16		5	4.81		79.79		4	1.03			
NAH	29.32		5	3.04		30.53		4	1.71			
NAW	24.07		5	2.00		23.07		4	2.79			
ZYG	135.20		5	3.70		127.25		4	6.95			
JNB	29.60		3	5.06		25.35		5	3.68			
CML	151.17	150.50	3	3	5.80	7.37	135.25	136.50	6	6	6.83	6.83
CAPD	11.29	11.99	3	3	0.55	0.84	10.71	10.46	6	6	0.44	0.75
CSID	9.42	9.23	3	3	1.20	0.12	8.68	8.87	6	6	0.42	0.78
C1	10.15		3	0.21		9.41		5	1.33			
XC2	39.56		4	6.57		31.27		6	2.77			
XC3	12.99		4	2.85		10.45		6	0.62			
XC4	11.51		4	0.95		10.66		6	0.78			
XC5	11.18		4	1.14		10.39		6	0.83			
XC6	11.22		4	0.76		11.20		6	0.40			
XC7	12.81		3	1.04		12.33		6	0.82			
XT1	15.61		3	0.93		14.32		6	0.94			
XT2	17.10		3	0.46		15.59		6	0.88			
XT3	17.58		3	0.79		16.53		6	0.73			
XT4	18.06		3	1.06		16.99		6	0.71			
XT5	18.93		3	1.12		17.44		6	0.51			
XT6	19.34		3	0.93		17.96		6	1.07			
XT7	19.95		3	1.22		18.51		6	1.02			
XT8	20.18		3	1.03		18.74		6	1.11			
XT9	20.93		3	0.82		19.66		6	0.75			
XT10	21.97		3	1.06		20.08		6	0.75			
XT11	22.93		3	0.69		21.58		6	1.30			
XT12	24.93		3	0.15		23.38		6	1.70			
XL1	26.76		3	0.64		24.08		6	2.12			
XL2	27.47		3	1.37		25.57		6	1.32			
XL3	28.09		3	1.33		26.00		6	1.09			
XL4	27.04		2	0.40		26.18		6	1.23			

SAN NICHOLAS ISLAND, CONTINUED

Dimension	MALES						FEMALES					
	Mean		n	Std. Dev.		Mean		n	Std. Dev.			
	left	right		left	right	left	right		left	right		
XL5	25.95		3	1.61		25.51		6	2.16			
S1	29.47		2	1.39		28.97		8	1.55			
SML	95.50		2	10.66		98.96		8	9.23			
HML	305.63	305.00	4	4	18.09	8.21	280.00	286.79	6	7	2.95	8.14
HEB	57.75	57.75	4	4	5.75	4.86	51.33	51.93	6	7	2.29	2.19
HHD	42.23	43.31	4	4	3.74	2.32	37.76	37.92	6	7	1.17	1.15
HMLD	19.99	20.78	4	4	2.56	3.54	18.76	17.75	6	7	1.31	1.24
HAPD	20.90	21.53	4	4	1.58	2.17	18.59	19.71	6	7	0.88	0.84
HAB	42.57	42.13	4	4	4.25	4.12	37.21	36.86	6	7	0.83	1.19
RML	234.17	237.00	3	4	11.02	7.12	217.07	219.00	7	6	6.41	8.16
RMLD	13.03	14.37	3	4	1.21	1.45	12.26	12.79	7	6	0.41	0.23
RAPD	11.00	11.42	3	4	0.07	0.78	10.49	10.66	7	6	0.51	0.49
RMLH	19.36	21.02	3	4	1.49	1.81	18.63	19.23	7	6	0.32	0.31
RAPH	20.49	21.67	3	4	1.86	2.18	19.62	19.79	7	6	0.44	0.40
RAB	23.83	24.78	3	4	1.92	1.63	23.15	23.25	6	6	0.85	1.22
UML	254.83	256.50	3	4	9.22	4.80	237.79	239.58	7	6	7.37	8.49
UMLD	11.81	12.10	3	4	0.66	0.94	11.00	10.82	7	6	0.75	0.79
UAPD	15.03	15.51	3	4	1.53	1.26	13.34	13.26	7	6	0.55	0.56
FML	431.25	426.13	4	4	7.54	14.42	402.33	403.19	6	8	10.62	11.64
FBL	426.13	420.33	4	3	7.51	14.89	396.83	397.56	6	8	10.10	11.06
FEB	76.63	77.00	4	4	3.68	3.85	71.50	71.06	6	8	0.71	2.41
FAB	67.68	68.99	4	4	1.87	3.28	62.91	62.40	6	8	2.06	2.29
FHD	43.15	42.94	4	3	2.67	1.74	39.45	40.23	6	8	1.43	1.45
FMLD	27.06	26.87	4	4	0.54	1.34	23.16	23.55	6	8	1.91	1.79
FAPD	28.64	29.16	4	4	1.50	2.29	25.39	26.13	6	8	0.86	1.83
TML	362.13	363.38	4	4	8.80	4.99	340.06	336.93	8	7	10.94	6.59
TFL	358.75	359.50	4	4	8.22	6.14	336.75	334.00	8	7	10.50	6.90
TPB	72.25	72.50	4	3	2.53	2.29	66.50	67.86	8	7	2.14	2.14
TPAB	70.24	70.83	4	3	2.70	1.52	64.54	65.77	8	7	1.70	1.82
TMLD	21.32	23.76	4	4	2.01	1.12	18.50	19.70	8	7	0.71	0.65
TAPD	27.48	26.72	4	4	1.30	1.50	24.57	23.73	8	7	2.00	2.38
FIML	345.33	346.67	3	3	5.35	2.89	323.75	325.17	6	6	9.26	8.66
BIB	259.75		2		8.13		269.71		7		16.21	
IBL	149.00	152.00	1	3		2.65	149.86	150.86	7	7	5.67	4.63
ACH	49.31	49.05	2	3	2.83	3.57	45.86	45.63	7	7	2.31	2.04
TCH	65.00	64.50	2	2	0.00	2.12	58.42	59.25	6	4	1.69	2.60
TTB	29.76	30.51	2	3	2.11	0.91	25.82	26.46	6	4	1.49	1.59

COOK

Dimension	MALES						FEMALES					
	Mean		n	Std. Dev.		Mean		n	Std. Dev.			
	left	right		left	right	left	right		left	right		
BBH	138.17		12	3.93		137.50		4	4.93			
GBL	176.89		9	7.04		174.25		4	6.70			
EUB	140.36		11	3.72		141.50		4	2.65			
UFH	81.25		8	4.31		76.53		4	3.47			
NAH	26.95		6	1.19		27.41		3	1.24			
NAW	24.00		12	1.00		23.47		4	0.55			
ZYG	138.09		11	4.64		134.75		4	5.25			
JNB	33.29		9	3.68		30.30		2	0.16			
CML	151.31	153.21	8	7	8.63	7.53	130.00	142.00	1	2	12.73	
CAPD	11.05	12.05	9	8	0.84	0.57	9.49	11.99	1	2	1.70	
CSID	9.74	10.32	9	8	0.52	0.44	7.81	10.16	1	2	0.71	
C1	11.26		10	0.94		12.01		2	2.08			
XC2	38.01		10	2.06		36.94		2	0.21			
XC3	13.40		10	1.09		11.46		2	0.91			
XC4	12.64		9	0.78		12.14		2	0.06			
XC5	12.78		8	1.40		11.74		2	0.35			
XC6	12.63		9	0.86		12.71		3	0.62			
XC7	14.59		8	0.99		14.36		3	0.51			
XT1	17.04		9	1.33		16.01		3	0.27			
XT2	17.77		11	0.80		17.56		3	0.09			
XT3	17.82		10	0.49		17.27		2	1.08			
XT4	18.58		9	0.33		17.22		2	1.75			
XT5	19.45		9	0.48		18.50		2	0.64			
XT6	20.43		10	0.65		18.85		2	1.24			
XT7	21.08		11	1.00		19.20		3	1.71			
XT8	21.94		11	1.22		20.22		3	2.01			
XT9	22.44		11	1.44		20.86		4	1.59			
XT10	23.05		11	1.62		22.31		3	0.71			
XT11	23.35		13	0.86		22.54		4	1.33			
XT12	24.67		13	1.48		24.03		4	1.12			
XL1	26.92		13	0.86		26.78		4	1.11			
XL2	27.09		13	1.22		27.10		4	0.73			
XL3	27.89		12	1.06		28.17		4	0.88			
XL4	28.79		12	1.04		28.58		4	0.90			

COOK, CONTINUED

Dimension	MALES						FEMALES					
	Mean		<i>n</i>		Std. Dev.		Mean		<i>n</i>		Std. Dev.	
	left	right			left	right	left	right			left	right
XL5	28.90		13		1.57		28.96		4		1.48	
S1	31.43		10		2.18		32.76		3		2.28	
SML	112.12		7		10.76		106.15		2		6.50	
HML	323.36	322.23	11	11	13.85	13.63	306.00	302.75	3	2	11.53	13.08
HEB	61.07	61.64	14	11	3.26	3.87	55.17	53.00	3	1	2.08	
HHD	46.14	46.50	12	10	1.74	1.82	40.90	42.35	3	2	1.30	1.24
HMLD	20.35	21.00	12	11	1.70	1.41	18.91	19.55	3	2	1.34	2.14
HAPD	19.82	21.04	12	11	1.43	1.02	18.57	16.52	3	2	1.15	1.58
HAB	45.03	44.65	14	11	2.28	2.16	41.47	43.59	3	1	2.31	
RML	249.25	251.73	10	13	11.66	13.27	239.17	233.00	3	1	19.64	
RMLD	13.63	13.83	11	13	1.44	1.19	12.83		3		0.43	
RAPD	11.52	11.91	11	13	0.97	0.82	10.45		3		0.08	
RMLH	21.70	21.84	11	12	0.69	0.94	20.91	21.10	3	1	0.96	
RAPH	22.53	22.80	11	12	0.60	1.03	21.26	21.75	3	1	0.75	
RAB	26.21	26.86	12	13	0.78	1.17	24.33		2		0.04	
UML	267.00	271.62	11	13	13.65	15.12	258.67	251.67	3	3	12.90	6.35
UMLD	12.87	13.02	12	13	1.30	1.21	11.27	11.27	3	3	0.45	0.59
UAPD	15.08	15.47	12	13	1.07	1.00	13.64	13.66	3	3	1.45	2.07
FML	453.56	458.13	9	12	16.96	16.54	437.50	440.00	3	4	10.50	11.17
FBL	451.56	452.96	8	11	17.31	17.38	430.67	434.75	3	4	11.93	11.35
FEB	82.55	83.25	10	12	4.12	4.08	73.67	73.83	3	3	0.76	1.76
FAB	73.00	73.68	10	13	3.69	3.55	66.37	66.71	3	3	0.95	0.31
FHD	45.71	46.50	10	13	1.90	2.14	41.99	42.39	4	4	0.38	1.12
FMLD	26.14	25.96	11	15	1.76	1.50	24.81	25.35	3	4	0.48	1.50
FAPD	28.27	28.98	11	15	2.01	2.26	24.21	25.20	3	4	1.54	1.64
TML	381.83	384.83	9	15	21.48	19.51	365.83	360.88	3	4	20.52	11.11
TFL	377.06	380.57	9	15	20.90	19.22	361.17	357.00	3	4	19.81	10.96
TPB	79.30	78.93	10	15	4.02	3.28	69.33	70.00	3	3	0.29	0.50
TPAB	77.00	77.40	10	15	3.96	3.56	68.35	68.99	3	3	1.00	0.93
TMLD	21.65	24.43	12	15	1.24	1.80	20.89	23.27	3	4	2.04	1.91
TAPD	30.90	28.85	12	15	2.86	2.34	26.86	25.61	2	4	3.15	1.44
FIML	379.00	367.44	3	9	23.29	22.11	354.75	337.00	2	2	24.40	0.71
BIB	277.20		10		13.65		268.00		1			
IBL	162.00	160.11	8	9	7.07	5.04	146.00	147.00	1	1		
ACH	51.90	51.66	11	12	1.79	1.89	48.00	49.15	1	2	2.16	
TCH	63.21	64.43	7	7	2.32	3.94	60.50	59.00	3	1	6.50	
TTB	30.68	30.78	9	8	1.38	1.33	28.60	28.46	2	3	1.17	.74

CUYAMA RANCH & TULAMNUI

Dimension	MALES						FEMALES					
	Mean		n	Std. Dev.		Mean		n	Std. Dev.			
	left	right		left	right	left	right		left	right		
BBH	135.00		4	2.16		127.83		6	6.08			
GBL	182.75		4	4.79		174.60		5	4.51			
EUB	138.00		4	2.16		137.00		4	4.08			
UFH	79.51		4	5.37		71.58		5	6.87			
NAH	30.46		4	2.02		27.07		6	1.98			
NAW	25.95		4	1.54		23.32		6	1.69			
ZYG	139.00		4	6.73		130.20		5	6.53			
JNB	24.54		2	0.42		21.82		2	0.21			
CML	149.50	143.75	5	4	6.96	9.08	128.88	128.17	4	3	15.56	16.75
CAPD	12.02	11.92	5	4	1.25	0.41	9.69	10.37	4	3	1.50	1.92
CSID	10.49	10.51	5	4	1.13	1.94	8.61	9.61	4	3	1.09	0.66
C1	11.15		4	0.54		10.61		5	0.56			
XC2	38.90		3	0.67		32.29		4	0.66			
XC3	13.02		3	2.12		10.96		4	1.81			
XC4	12.40		3	0.40		11.30		2	2.31			
XC5	11.38		3	0.81		10.68		3	1.47			
XC6	11.65		4	0.61		11.30		4	0.51			
XC7	13.33		4	0.56		12.37		3	0.90			
XT1	16.18		6	0.83		15.04		4	1.69			
XT2	18.23		5	1.55		17.06		6	1.25			
XT3	18.72		4	1.19		16.68		6	0.95			
XT4	18.29		4	1.11		17.09		5	1.06			
XT5	18.65		4	1.05		18.00		5	1.06			
XT6	19.95		4	1.25		18.42		5	1.46			
XT7	20.09		4	1.24		19.36		6	1.47			
XT8	20.61		4	1.14		18.88		5	1.66			
XT9	21.34		4	1.45		19.12		5	1.47			
XT10	21.64		4	1.68		19.79		5	1.43			
XT11	21.95		4	0.65		21.73		6	2.71			
XT12	23.22		4	0.64		21.55		5	2.36			
XL1	24.90		5	0.78		23.58		5	2.46			
XL2	24.88		5	0.89		24.68		6	2.86			
XL3	25.44		5	1.49		25.61		6	3.02			
XL4	26.89		6	2.12		26.10		6	2.72			

CUYAMA RANCH & TULAMNUI, CONTINUED

Dimension	MALES						FEMALES					
	Mean		n	Std. Dev.		Mean		n	Std. Dev.			
	left	right		left	right	left	right		left	right		
XL5	26.84		6	2.64		26.72		6	2.40			
S1	29.53		4	3.74		29.06		6	2.64			
SML	110.22		4	17.87		99.02		6	10.62			
HML	319.40	320.83	5	6	18.27	16.06	277.75	285.63	4	4	24.96	25.99
HEB	59.25	59.63	6	4	3.40	3.64	50.70	50.88	5	4	5.66	5.63
HHD	43.74	43.60	5	6	3.10	3.60	38.63	40.18	4	4	3.77	3.25
HMLD	21.06	21.80	6	6	1.16	1.57	16.52	17.90	4	4	3.17	2.60
HAPD	21.32	21.51	6	6	2.19	1.28	17.51	18.08	4	4	1.69	1.88
HAB	43.42	43.86	6	4	3.40	3.27	36.70	37.84	5	4	4.22	4.33
RML	239.70	252.67	5	3	11.97	9.71	221.38	216.70	4	5	18.40	19.09
RMLD	14.08	15.17	5	4	1.46	1.76	12.45	11.85	5	5	1.79	1.45
RAPD	11.93	12.19	5	4	1.07	1.41	10.66	9.89	5	5	1.82	1.02
RMLH	21.60	21.87	5	4	0.82	2.07	19.09	19.09	4	5	1.98	1.04
RAPH	22.16	22.95	5	3	0.94	2.27	20.50	19.34	3	5	1.17	1.44
RAB	24.90	25.39	5	4	1.11	1.77	23.85	22.93	4	6	1.49	0.97
UML	262.00	268.25	5	2	16.46	14.50	234.20	236.00	5	5	22.97	22.82
UMLD	13.01	13.19	6	3	1.48	1.70	11.08	10.80	5	5	1.35	0.93
UAPD	16.46	15.30	6	3	1.58	1.78	12.84	12.63	5	5	2.09	1.13
FML	440.10	428.83	5	3	24.42	19.70	388.50	393.17	5	6	31.76	29.36
FBL	439.38	426.00	4	2	26.16	25.46	384.90	389.25	5	6	29.52	27.87
FEB	79.50	79.00	5	6	3.34	3.33	69.20	70.70	5	5	4.49	4.60
FAB	69.24	69.20	5	6	2.03	2.51	58.53	59.86	4	5	4.39	4.61
FHD	44.24	43.85	6	3	2.62	2.15	40.11	40.56	5	6	2.83	2.49
FMLD	26.58	26.74	5	4	0.35	0.69	22.69	23.72	5	6	1.90	2.92
FAPD	29.28	29.39	5	4	1.61	2.03	24.94	25.00	5	6	1.57	1.60
TML	366.13	372.60	4	5	15.16	16.05	325.40	327.67	5	6	31.79	27.32
TFL	362.38	369.80	4	5	15.78	16.02	321.80	324.15	5	6	31.35	26.93
TPB	73.10	73.42	5	6	2.77	3.28	65.50	65.90	5	5	5.29	5.24
TPAB	70.89	71.51	5	6	3.55	2.64	62.15	63.83	5	5	4.29	4.77
TMLD	22.33	24.01	4	5	1.12	0.66	19.74	21.01	5	6	1.80	2.15
TAPD	29.29	28.57	4	5	2.52	3.33	25.06	25.16	5	6	2.34	2.53
FIML	351.13	360.88	4	4	18.85	7.71	315.75	308.33	6	3	27.94	29.84
BIB	265.17		3		5.30		250.75		6		25.74	
IBL	151.33	154.50	3	2	3.51	2.12	143.60	148.20	5	5	13.87	11.52
ACH	46.63	49.86	3	2	2.63	0.03	45.31	44.76	6	6	3.19	3.01
TCH	64.17	64.00	3	4	3.33	2.45	56.25	57.50	4	4	6.08	5.79
TTB	27.22	27.65	3	4	1.85	0.72	26.06	26.18	5	5	1.41	1.63

ELLIS LANDING

Dimension	MALES						FEMALES					
	Mean		<i>n</i>	Std. Dev.		Mean		<i>n</i>	Std. Dev.			
	left	right		left	right	left	right		left	right		
BBH	140.67		3	3.79		132.00		1				
GBL	183.00		2	0.00		182.00		1				
EUB	142.50		2	9.19		141.00		1				
UFH	80.36		2	2.53		74.44		2	5.45			
NAH	28.68		2	2.14		25.14		1				
NAW	25.96		5	0.78		23.27		2	0.43			
ZYG	144.00		3	4.58		133.00		2	4.24			
JNB	32.20		5	4.13		31.59		3	3.91			
CML	150.33	147.00	6	7	7.23	10.34	135.80	137.63	5	4	6.50	7.72
CAPD	12.08	12.49	6	7	0.96	1.05	10.70	10.70	5	4	0.53	0.81
CSID	10.55	10.20	6	7	1.53	1.08	8.70	8.98	5	4	0.52	0.39
C1	11.83		3	1.16		9.94		2	0.36			
XC2	42.22		4	6.94		35.61		5	2.10			
XC3	14.11		4	1.49		12.44		5	0.77			
XC4	15.11		6	5.88		11.64		5	0.54			
XC5	13.32		5	1.21		10.95		3	1.18			
XC6	13.55		7	1.35		11.57		5	0.92			
XC7	14.63		4	0.74		13.02		4	1.40			
XT1	16.25		4	1.32		15.37		4	1.43			
XT2	18.13		5	0.75		16.56		4	1.10			
XT3	17.89		4	0.79		16.93		4	1.26			
XT4	18.64		4	1.10		17.85		3	2.38			
XT5	19.35		3	1.39		17.45		3	1.17			
XT6	20.18		5	1.24		18.67		6	0.91			
XT7	20.42		6	1.26		19.31		3	1.38			
XT8	20.91		6	1.22		20.01		4	1.99			
XT9	21.30		5	1.51		20.00		3	1.89			
XT10	22.03		7	1.15		20.49		3	1.56			
XT11	22.70		11	1.28		22.31		6	2.39			
XT12	24.41		11	1.56		24.21		5	2.83			
XL1	26.10		11	2.14		25.42		6	2.61			
XL2	26.13		8	1.64		25.62		5	2.47			
XL3	27.16		7	1.61		26.36		5	1.54			
XL4	27.44		9	1.23		26.45		7	1.46			

ELLIS LANDING, CONTINUED

Dimension	MALES						FEMALES					
	Mean		n		Std. Dev.		Mean		n		Std. Dev.	
	left	right			left	right	left	right			left	right
XL5	28.29		9		2.03		25.90		7		1.83	
S1	30.55		10		2.38		28.71		6		1.60	
SML	115.64		8		9.45		109.68		3		11.94	
HML	309.56	315.85	9	10	13.33	8.89	295.60	306.13	5	4	13.60	9.72
HEB	60.82	61.10	11	10	3.57	3.91	53.40	53.58	5	6	2.41	2.56
HHD	45.27	46.74	9	10	2.05	2.53	40.31	40.64	5	4	2.53	2.13
HMLD	22.24	22.52	10	10	2.29	2.58	20.41	20.07	5	4	1.90	1.56
HAPD	21.32	21.92	10	10	2.23	2.30	18.43	18.86	5	4	0.86	1.06
HAB	45.55	45.59	11	10	2.60	2.77	40.61	41.03	5	5	1.95	2.74
RML	246.73	244.31	11	8	13.20	15.31	231.60	235.13	5	4	4.57	3.38
RMLD	15.21	15.54	10	10	1.44	1.19	13.97	14.02	6	5	1.25	1.42
RAPD	12.18	12.46	10	10	1.15	0.94	10.70	11.31	6	5	0.62	0.56
RMLH	21.92	22.26	11	10	1.17	1.49	19.93	20.30	6	5	0.89	1.11
RAPH	22.89	23.04	11	9	1.46	1.30	20.42	20.59	6	5	1.16	1.50
RAB	26.24	26.31	10	10	1.69	1.16	23.88	24.66	5	5	0.99	0.71
UML	264.70	264.88	10	8	12.53	14.66	252.67	252.40	3	5	3.33	4.28
UMLD	12.75	13.49	9	12	1.23	0.95	11.99	11.78	6	5	1.00	0.86
UAPD	15.08	15.70	9	12	1.33	1.56	14.11	14.48	6	5	1.39	1.44
FML	445.67	440.67	9	6	18.43	23.80	431.42	426.08	6	6	13.69	15.14
FBL	439.71	437.33	7	6	20.05	23.42	425.30	421.08	5	6	13.61	14.75
FEB	83.00	82.80	7	5	4.67	5.30	73.80	74.10	5	5	3.29	2.72
FAB	74.96	74.61	7	5	3.96	2.92	64.51	66.11	5	5	2.97	3.31
FHD	47.43	47.42	11	8	2.86	2.73	41.24	41.03	6	7	1.56	1.49
FMLD	28.43	27.93	10	7	2.27	2.52	26.10	26.17	6	6	1.42	1.25
FAPD	29.76	30.03	10	7	2.28	2.63	27.99	27.85	6	6	2.51	2.60
TML	369.00	368.38	9	8	16.63	18.36	359.17	356.13	6	4	17.79	21.17
TFL	365.61	364.89	9	8	16.02	18.64	356.00	352.75	6	4	17.25	21.08
TPB	78.67	78.67	9	6	3.72	4.00	70.42	70.50	6	5	4.55	3.94
TPAB	76.98	77.13	9	6	3.64	4.02	69.30	69.26	6	5	4.29	4.03
TMLD	22.53	25.25	9	10	1.63	2.24	20.07	22.87	7	4	1.49	1.98
TAPD	30.40	29.11	9	10	2.43	2.00	28.28	27.74	7	4	1.85	1.43
FIML	354.92	353.00	6	6	20.35	20.80	351.50	338.00	2	1	24.75	
BIB	277.13		8		14.08		272.50		4		19.71	
IBL	154.33	146.00	6	4	3.44	6.68	151.25	153.00	4	6	11.35	9.92
ACH	51.88	52.43	8	7	3.19	2.75	46.85	46.37	4	5	1.69	1.25
TCH	65.08	66.50	6	7	5.49	4.92	60.40	61.08	5	6	3.65	3.04
TTB	31.29	31.99	9	7	2.37	3.26	28.39	28.62	5	7	2.38	1.86

SACRAMENTO RIVER VALLEY SITES

Dimension	MALES						FEMALES					
	Mean		n	Std. Dev.		Mean		n	Std. Dev.			
	left	right		left	right	left	right		left	right		
BBH	140.71		7	5.53		134.44		9	6.91			
GBL	178.57		7	5.77		169.78		9	4.35			
EUB	142.86		7	3.93		139.22		9	3.19			
UFH	81.89		7	3.87		75.60		9	3.55			
NAH	30.22		7	2.60		26.83		9	1.33			
NAW	24.21		7	1.60		23.01		9	.94			
ZYG	138.14		7	5.01		131.33		9	2.74			
JNB	26.62		4	1.78		22.07		5	1.76			
CML	153.10	151.50	5	7	15.13	14.96	136.71	135.08	7	6	8.58	9.25
CAPD	11.02	11.43	5	7	1.45	1.56	10.05	11.07	7	6	0.73	1.29
CSID	10.75	9.99	5	7	1.94	1.58	8.46	8.77	7	6	0.84	0.82
C1	10.97		7	1.14		10.19		7	0.71			
XC2	36.44		8	2.28		35.51		8	3.03			
XC3	12.70		8	0.65		11.94		8	1.10			
XC4	13.53		6	2.35		11.73		7	0.67			
XC5	12.36		7	1.70		11.70		8	0.97			
XC6	12.11		8	1.36		12.07		8	0.80			
XC7	13.77		7	1.30		13.10		8	0.70			
XT1	16.08		7	1.15		15.03		7	0.81			
XT2	18.06		8	1.27		17.02		7	0.31			
XT3	18.39		8	0.96		17.32		7	0.93			
XT4	18.46		8	0.94		18.12		7	0.82			
XT5	19.00		8	1.26		18.32		8	1.19			
XT6	19.95		8	1.22		18.98		8	1.20			
XT7	20.51		8	1.16		19.51		8	1.40			
XT8	20.55		8	1.01		19.80		8	1.33			
XT9	21.16		8	1.13		20.42		8	1.03			
XT10	21.68		8	0.87		20.93		8	0.57			
XT11	22.69		7	0.86		21.71		8	0.71			
XT12	24.89		7	1.32		24.19		8	1.24			
XL1	25.85		8	1.66		25.32		8	1.21			
XL2	26.17		7	1.63		25.85		8	1.05			
XL3	26.69		7	1.40		25.98		8	1.16			
XL4	27.51		8	2.14		27.11		9	1.33			

SACRAMENTO RIVER VALLEY SITES, CONTINUED

Dimension	MALES						FEMALES					
	Mean		n	Std. Dev.		Mean		n	Std. Dev.			
	left	right		left	right	left	right		left	right		
XL5	27.72		8	1.72		27.31		9	1.95			
S1	29.55		8	2.54		29.01		7	1.08			
SML	109.74		8	7.01		104.35		6	5.54			
HML	321.50	322.86	6	7	26.73	25.11	292.75	295.93	8	7	18.87	17.77
HEB	61.36	62.21	7	7	4.10	4.05	55.56	54.58	9	6	2.47	2.13
HHD	44.70	46.01	7	8	3.57	3.54	40.85	40.82	8	7	1.55	2.02
HMLD	20.76	20.88	6	7	2.10	1.52	18.93	19.03	9	7	1.66	1.80
HAPD	20.20	20.82	6	7	1.82	1.77	18.68	18.75	9	7	1.21	1.41
HAB	44.60	46.00	7	7	3.46	3.20	40.03	40.31	9	6	1.56	2.38
RML	252.50	254.07	7	7	19.19	20.92	227.06	227.06	8	8	13.56	13.33
RMLD	14.11	14.18	7	7	0.92	0.79	13.56	13.35	8	8	1.43	1.45
RAPD	11.51	11.86	7	7	0.91	1.12	10.45	10.45	8	8	0.75	0.52
RMLH	22.22	22.33	7	7	2.09	2.25	19.96	19.52	8	8	0.84	0.77
RAPH	23.06	23.29	7	7	2.07	2.29	20.72	19.93	8	8	0.92	1.28
RAB	26.34	26.24	8	8	1.26	1.57	24.60	24.15	8	8	1.53	1.18
UML	273.21	277.42	7	6	18.79	16.76	249.43	247.08	7	6	13.73	14.30
UMLD	13.13	13.10	7	6	1.37	1.63	11.08	11.65	7	6	0.77	0.69
UAPD	15.24	15.91	7	6	1.83	1.90	14.74	14.35	7	6	1.08	1.30
FML	447.44	444.71	8	7	35.18	37.48	418.44	415.94	8	8	14.32	16.15
FBL	442.44	439.36	8	7	36.41	38.81	413.13	411.63	8	8	14.74	16.78
FEB	79.06	79.71	8	7	6.43	7.07	72.64	73.31	7	8	2.23	2.42
FAB	68.04	68.39	8	7	6.13	7.26	62.01	63.14	7	8	1.66	2.00
FHD	45.61	45.72	8	7	3.75	4.13	41.61	41.38	8	8	1.47	1.25
FMLD	26.22	26.23	8	7	2.23	2.31	24.93	24.88	8	8	0.94	1.45
FAPD	27.22	27.55	8	7	2.64	3.12	24.95	25.36	8	8	1.72	1.73
TML	378.38	377.63	8	8	32.42	33.55	348.72	354.43	9	7	15.31	15.27
TFL	374.44	373.94	8	8	31.34	32.64	345.39	351.14	9	7	15.77	14.74
TPB	75.19	75.43	8	7	6.28	6.46	67.44	69.43	8	7	1.68	2.37
TPAB	72.23	71.90	8	7	6.42	7.46	64.99	66.90	8	7	2.28	1.88
TMLD	22.25	24.09	8	8	1.62	2.23	19.53	20.63	9	7	0.64	1.56
TAPD	28.52	28.29	8	8	3.42	3.84	23.82	25.08	9	7	1.52	1.17
FIML	359.20	358.75	5	6	38.78	36.37	338.58	336.58	6	6	14.32	13.25
BIB	269.13		8		19.29		263.07		7		13.60	
IBL	162.40	160.38	5	8	7.37	7.13	151.50	152.22	8	9	6.89	6.16
ACH	51.53	50.10	7	8	4.74	3.83	46.78	46.37	7	8	1.47	2.07
TCH	64.07	64.00	7	7	5.07	5.10	58.08	58.10	6	5	1.91	2.46
TTB	29.00	28.65	7	7	2.23	2.68	25.97	25.34	6	6	0.94	0.75

KARLO

Dimension	MALES					FEMALES						
	Mean		n	Std. Dev.		Mean		n	Std. Dev.			
	left	right		left	right	left	right		left	right		
BBH	131.00		1			135.00		5	6.28			
GBL	193.00		1			189.75		4	15.92			
EUB	137.00		1			138.00		4	9.83			
UFH	80.12		1			80.24		5	5.37			
NAH	29.82		1			28.05		4	3.73			
NAW	26.95		1			24.94		5	1.23			
ZYG	141.00		1			140.60		5	7.27			
JNB	28.86		1			28.93		4	5.31			
CML	153.00	159.75	1	2		10.25	132.38	133.80	4	5	6.87	15.61
CAPD	11.33	11.33	1	2		1.97	10.27	11.94	4	5	0.77	1.60
CSID	8.17	8.98	1	2		0.52	8.59	8.87	4	5	0.32	0.73
C1	10.83		1			9.73		2	0.21			
XC2	37.86		1			33.48		4	1.73			
XC3	12.55		1			11.60		4	0.51			
XC4	12.13		1			11.56		3	0.54			
XC5	11.23		1			11.03		4	0.76			
XC6	11.29		1			11.03		3	0.70			
XC7	12.80		1			12.72		3	1.09			
XT1	16.06		2	1.26		15.68		5	1.24			
XT2	17.42		2	1.37		16.52		5	1.51			
XT3	17.52		2	1.05		18.18		4	1.14			
XT4	17.76		1			18.40		5	1.71			
XT5	19.89		1			19.08		5	1.50			
XT6	20.39		2	0.31		19.41		6	1.31			
XT7	20.29		1			19.93		6	1.31			
XT8	21.20		1			20.80		6	0.98			
XT9	22.62		2	1.15		21.51		6	1.52			
XT10	22.59		2	2.07		21.67		6	1.70			
XT11	23.17		2	1.78		22.83		6	1.73			
XT12	25.52		2	0.35		25.10		6	1.90			
XL1	26.02		2	1.24		26.55		6	1.72			
XL2	26.07		2	1.29		27.24		5	1.31			
XL3	26.55		2	0.57		27.98		6	1.13			
XL4	26.30		2	0.37		27.98		5	1.79			

KARLO, CONTINUED

Dimension	MALES						FEMALES					
	Mean		n	Std. Dev.		Mean		n	Std. Dev.			
	left	right		left	right	left	right		left	right		
XL5	26.94		2	0.32		27.65		5	2.21			
S1	30.38		2	1.15		29.73		5	1.65			
SML						106.94		4	8.57			
HML	306.50	315.25	1	2		8.13	293.60	291.86	5	7	21.22	22.01
HEB	59.00	60.25	1	2		0.35	56.00	57.90	5	5	2.72	2.70
HHD	45.55	44.91	1	2		1.41	42.40	41.65	5	7	2.80	3.41
HMLD	20.70	19.76	1	2		3.76	20.36	20.07	5	7	1.41	1.77
HAPD	20.16	20.22	1	2		1.99	18.92	19.12	5	7	1.14	1.22
HAB	44.67	43.32	1	2		1.33	39.22	39.61	5	5	2.26	3.18
RML	247.00	244.00	2	1	8.49		212.63	228.00	4	4	12.49	24.33
RMLD	14.53	14.72	2	2	0.37	0.86	13.85	14.15	5	4	1.20	1.71
RAPD	11.69	11.51	2	2	1.06	0.37	10.67	11.04	5	4	1.17	1.29
RMLH	21.64	21.97	2	2	0.45	0.69	20.02	20.35	5	5	1.58	1.96
RAPH	22.68	22.94	2	2	0.98	0.76	20.73	20.84	5	5	1.87	2.23
RAB	24.72	26.66	2	1	0.17		22.94	23.00	3	5	1.04	2.69
UML	265.50	265.75	2	2	7.78	10.25	241.90	266.50	5	2	24.47	21.21
UMLD	12.58	11.94	2	2	0.77	0.68	11.90	12.05	5	4	1.06	1.59
UAPD	14.70	13.47	2	2	0.81	0.86	13.57	14.10	5	4	1.03	0.90
FML	448.50	448.25	2	2	19.09	22.27	413.21	411.50	7	7	33.25	31.21
FBL	445.75	443.00	2	2	18.74	19.09	408.50	406.36	7	7	32.04	30.61
FEB	83.25	81.75	2	2	1.06	0.35	74.30	74.67	5	6	2.36	2.68
FAB	72.75	70.79	2	2	0.93	1.60	63.70	63.76	6	6	2.87	2.57
FHD	45.48	45.59	2	2	0.18	0.55	42.30	42.73	7	7	3.56	2.94
FMLD	24.46	26.25	2	2	2.23	0.66	25.62	25.78	6	7	2.76	2.39
FAPD	28.06	26.80	2	2	0.72	0.19	24.40	25.12	6	7	2.34	2.24
TML	370.25	367.25	2	2	11.67	13.08	350.42	345.42	6	6	33.71	35.94
TFL	367.00	365.25	2	2	8.49	12.37	347.92	342.17	6	6	33.91	36.10
TPB	78.75	77.50	2	2	1.77	1.41	72.50	69.86	3	7	4.36	2.78
TPAB	77.18	75.19	2	2	3.34	0.99	68.74	67.97	4	7	4.63	3.01
TMLD	20.52	23.52	2	2	1.36	1.10	19.44	20.91	5	7	2.07	1.57
TAPD	28.71	26.73	2	2	1.00	0.77	26.25	25.00	5	7	2.10	3.15
FIML	359.25	359.75	2	2	13.08	11.67	344.67	330.20	3	5	48.69	39.46
BIB	278.00		1				277.75		4		11.15	
IBL	160.00	158.00	1	1			153.80	152.33	5	6	6.80	7.17
ACH	51.35	50.22	2	1	0.66		48.22	47.06	5	5	2.96	0.86
TCH	67.25	67.50	2	1	1.06		61.92	61.70	6	5	4.22	1.20
TTB	30.03	28.71	2	1	0.49		28.77	29.06	6	6	1.00	1.41

LA JOLLA

Dimension	MALES						FEMALES					
	Mean		n	Std. Dev.		Mean		n	Std. Dev.			
	left	right		left	right	left	right		left	right		
BBH	142.20		10	7.22		131.00		12	7.90			
GBL	189.80		10	9.28		179.25		12	7.31			
EUB	144.20		10	3.46		134.33		12	7.14			
UFH	82.40		7	4.60		78.48		11	3.49			
NAH	26.68		4	3.33		26.78		10	2.20			
NAW	23.60		8	1.37		24.17		11	1.60			
ZYG	142.75		8	3.54		131.09		11	4.61			
JNB						26.60		2	2.35			
CML	150.00	144.00	2	2	2.83	0.00	134.00	131.00	3	4	2.00	2.83
CAPD	10.92	11.35	2	2	0.43	0.01	9.58	9.78	3	4	0.86	1.51
CSID	8.57	8.45	2	2	0.53	0.57	7.90	7.95	3	4	1.04	0.23
C1	10.91		4	2.03		10.25		4	0.30			
XC2	35.51		2	1.67		34.49		4	1.06			
XC3	12.30		2	0.78		11.40		4	0.91			
XC4	12.01		1			10.91		3	0.15			
XC5	11.12		1			11.18		3	0.79			
XC6	11.85		3	1.14		10.90		3	1.18			
XC7						12.60		2	0.01			
XT1	14.79		3	1.11		15.37		4	0.71			
XT2	17.41		4	0.88		16.27		4	0.80			
XT3	18.43		2	0.34		16.66		4	0.80			
XT4						17.78		4	0.89			
XT5						18.70		4	0.21			
XT6						19.08		4	0.52			
XT7	19.90		1			19.49		3	0.14			
XT8	21.37		2	0.75		20.34		2	0.37			
XT9	21.19		1			20.97		2	0.14			
XT10	22.15		1			21.66		2	0.01			
XT11	20.62		2	0.86		23.13		4	1.30			
XT12	23.26		2	0.42		25.08		4	1.89			
XL1	25.63		1			25.91		5	0.97			
XL2	25.87		1			27.23		5	1.50			
XL3	26.11		1			27.19		4	1.04			
XL4	25.87		1			27.43		4	1.01			

LA JOLLA, CONTINUED

Dimension	MALES						FEMALES					
	Mean		n	Std. Dev.		Mean		n	Std. Dev.			
	left	right		left	right	left	right		left	right		
XL5	26.43		2	0.60		28.02		5	1.31			
S1	31.71		2	1.46		28.17		3	3.19			
SML	120.04		2	6.60		99.45		3	17.71			
HML	301.57	311.92	7	6	8.90	10.12	299.63	285.92	4	6	12.74	20.90
HEB	61.00	61.83	6	6	1.45	3.11	55.75	55.88	4	4	1.85	2.39
HHD	44.37	42.59	3	4	0.44	3.12	40.53	40.23	5	5	2.20	2.79
HMLD	20.10	21.29	7	6	1.44	1.15	21.22	19.70	3	7	1.20	3.05
HAPD	19.43	20.98	7	6	1.20	1.24	19.55	19.14	3	7	2.25	2.74
HAB	41.39	44.46	5	6	1.95	2.20	39.72	39.92	2	3	1.41	3.73
RML	233.90	248.50	5	2	9.65	0.71	221.13		4		14.77	
RMLD	13.33	14.68	5	2	1.31	2.25	12.81	12.65	4	1	1.99	
RAPD	10.67	11.31	5	2	0.61	0.26	10.09	10.85	4	1	0.92	
RMLH	21.10	22.40	3	1	0.61		19.45		4		1.45	
RAPH	22.37	23.43	3	1	0.69		20.42		3		1.91	
RAB	25.18	25.72	3	1	1.11		23.11	21.71	3	1	1.89	
UML	252.75	261.00	4	2	4.11	0.00	239.00	242.50	3	2	14.93	17.68
UMLD	12.35	12.58	3	2	0.73	0.25	12.06	11.63	3	2	1.09	0.27
UAPD	13.97	14.95	3	2	1.49	1.68	14.07	16.14	3	2	1.10	0.45
FML	444.00	426.00	6	3	18.40	22.54	413.40	413.00	5	4	21.08	26.01
FBL	436.90	423.00	5	3	16.39	21.70	408.20	409.38	5	4	19.58	24.84
FEB	81.00	81.63	5	4	3.94	3.64	72.17	73.40	3	5	0.76	2.90
FAB	71.01	70.92	5	4	3.64	4.42	62.69	66.01	4	5	1.92	2.76
FHD	44.66	44.16	6	5	2.59	2.47	40.08	41.14	5	5	1.07	2.63
FMLD	25.77	24.77	6	7	1.65	1.00	24.50	24.97	5	7	2.08	2.24
FAPD	29.59	28.28	6	7	1.95	1.42	26.12	26.66	5	7	3.35	2.77
TML	367.30	351.75	5	2	11.63	21.57	351.38	352.38	4	4	22.01	17.86
TFL	359.00	348.75	4	2	8.91	20.86	349.20	349.16	4	4	22.90	18.34
TPB	76.25	77.50	4	2	2.22	3.54	71.17	74.50	3	1	3.79	
TPAB	73.72	75.66	4	2	1.46	5.06	69.00	73.59	3	1	2.15	
TMLD	20.36	21.56	5	5	1.57	1.83	20.59	21.70	4	5	2.03	2.21
TAPD	28.25	25.77	5	5	2.28	1.58	25.23	24.55	4	5	2.70	3.24
FIML	345.50	311.92	2	6	14.85		336.50	336.25	2	2	14.85	16.62
BIB	285.50		2		0.71		272.25		4		9.95	
IBL	158.50	152.67	2	3	7.78	9.45	148.33	153.00	3	1	1.53	
ACH		51.53		2		1.82	45.78	46.27	5	4	2.07	1.52
TCH	63.33	66.13	3	4	1.89	3.28	61.00	60.20	2	5	0.00	2.51
TTB	31.39	31.15	4	6	0.68	1.60	27.99	27.91	3	5	1.34	1.65

MUSTANG MOUND

Dimension	MALES						FEMALES					
	Mean		n	Std. Dev.		Mean		n	Std. Dev.			
	left	right		left	right	left	right		left	right		
BBH	140.86		7	5.81		133.00		7	3.92			
GBL	180.50		6	8.22		177.29		7	4.72			
EUB	140.00		7	4.28		138.57		7	4.35			
UFH	82.06		6	2.25		78.70		7	2.39			
NAH	29.07		6	2.35		28.40		7	2.23			
NAW	24.59		7	1.78		25.16		7	1.30			
ZYG	140.57		7	6.63		135.00		7	5.77			
JNB	31.77		1			28.54		1				
CML	152.90	151.64	5	7	5.44	7.04	142.83	137.50	3	3	6.25	6.25
CAPD	11.99	12.24	5	7	0.63	0.93	10.55	10.63	3	3	0.19	0.19
CSID	10.78	10.39	5	7	1.43	0.64	9.56	9.18	3	3	0.64	0.64
C1	11.09		2	0.58		9.67		2	0.88			
XC2	38.39		1			35.28		2	1.96			
XC3	12.34		1			11.00		2	0.28			
XC4	11.29		1			11.49		1				
XC5						10.70		1				
XC6						11.25		1				
XC7						12.61		1				
XT1	16.26		1			14.14		1				
XT2	19.52		1			17.13		1				
XT3	18.87		1			16.38		1				
XT4	20.65		1			17.44		1				
XT5	21.21		1			18.48		1				
XT6	21.85		1			18.91		1				
XT7	22.11		1			20.16		1				
XT8	23.83		1			18.69		1				
XT9	24.34		1			19.14		1				
XT10	24.56		1			20.26		1				
XT11	24.52		1			20.61		1				
XT12	26.40		1			22.26		1				
XL1	25.67		1			22.37		1				
XL2	26.16		1			22.20		1				
XL3	26.60		1			25.59		1				
XL4	26.62		1			25.12		1				

MUSTANG MOUND, CONTINUED

Dimension	MALES						FEMALES					
	Mean		n		Std. Dev.		Mean		n		Std. Dev.	
	left	right			left	right	left	right			left	right
XL5	27.77		1				25.67		1			
S1	31.52		9		2.07		27.41		6		1.43	
SML	115.62		8		8.00		104.38		6		10.95	
HML	316.50	315.75	9	8	18.77	17.91	292.83	297.00	6	7	5.50	5.83
HEB	61.44	61.31	8	8	1.45	2.07	56.67	56.50	6	7	1.40	2.38
HHD	45.96	46.31	9	8	1.85	2.56	41.29	41.40	6	7	1.32	1.26
HMLD	21.37	20.93	9	8	1.81	1.05	18.98	18.67	6	7	1.21	1.60
HAPD	20.93	21.97	9	8	1.13	1.57	18.89	19.64	6	7	0.97	1.14
HAB	46.87	46.29	8	8	2.54	2.96	41.62	40.88	6	7	1.47	2.68
RML	245.38	248.50	8	8	13.88	16.93	227.90	232.50	5	6	8.06	6.12
RMLD	14.16	14.15	9	8	1.50	1.14	13.57	13.39	5	6	1.19	0.62
RAPD	12.50	12.53	9	8	0.77	0.78	10.71	10.99	5	6	0.42	0.38
RMLH	22.89	22.41	7	8	0.63	0.84	20.04	20.44	5	6	0.41	0.87
RAPH	23.59	23.24	7	8	0.73	0.76	20.71	21.26	5	6	0.69	1.38
RAB	26.35	25.74	9	8	1.45	1.19	23.48	24.53	5	7	1.38	0.71
UML	265.69	271.05	8	10	13.03	16.74	248.64	252.06	7	8	8.88	6.17
UMLD	13.81	13.76	8	10	0.95	0.68	11.85	11.78	7	8	1.23	0.87
UAPD	15.56	15.91	8	10	1.23	1.23	14.08	14.82	7	8	1.02	1.21
FML	449.44	445.56	9	9	20.70	20.21	419.25	418.75	6	6	10.93	11.37
FBL	444.67	439.11	9	9	21.24	21.27	414.00	414.33	6	6	11.39	11.25
FEB	82.28	82.50	9	9	2.55	1.71	74.21	75.40	7	5	3.24	2.46
FAB	72.63	72.88	9	9	3.01	2.93	66.49	67.00	7	5	2.10	1.57
FHD	47.21	46.89	9	9	1.26	1.05	41.93	41.76	6	6	1.25	2.17
FMLD	26.36	26.25	9	9	1.46	1.13	25.15	25.57	6	6	1.33	1.53
FAPD	29.53	29.13	9	9	2.22	1.14	25.53	25.35	6	6	0.95	1.36
TML	379.55	378.75	10	10	17.52	16.68	350.50	350.14	6	7	9.81	7.70
TFL	375.90	375.05	10	10	17.15	16.10	347.17	346.43	6	7	9.89	8.52
TPB	77.55	77.95	10	10	1.99	2.42	70.36	71.29	7	7	2.93	1.15
TPAB	76.14	76.16	10	10	2.24	2.54	69.01	69.55	7	7	3.32	0.86
TMLD	21.10	23.79	10	10	1.80	2.92	18.71	21.42	7	7	0.72	0.81
TAPD	30.15	28.72	10	10	2.11	1.88	27.06	25.17	7	7	2.14	2.43
FIML	358.29	359.58	7	6	12.21	17.62	340.63	339.10	4	5	6.92	6.82
BIB	276.94		9		11.92		271.25		6		9.78	
IBL	155.50	157.88	8	8	6.05	4.88	154.50	153.83	8	6	4.44	4.88
ACH	52.31	52.11	10	10	1.70	1.06	47.11	46.68	8	6	1.36	2.39
TCH	70.00	69.00	1	1			63.00	63.50	1	1		
TTB	30.28	30.00	1	1			27.95	26.70	1	1		

NEED 1

Dimension	MALES						FEMALES					
	Mean		<i>n</i>	Std. Dev.		Mean		<i>n</i>	Std. Dev.			
	left	right		left	right	left	right		left	right		
BBH	139.54		11	5.22		136.54		11	2.38			
GBL	181.73		11	4.86		177.09		11	7.31			
EUB	141.46		11	6.09		138.09		11	4.11			
UFH	82.33		10	3.59		77.74		11	2.21			
NAH	29.26		7	2.62		27.34		11	2.26			
NAW	24.86		10	1.59		24.05		11	1.87			
ZYG	140.80		10	4.96		133.64		11	5.26			
JNB	29.89		8	3.30		26.78		6	3.07			
CML	156.38	155.50	8	8	9.11	8.66	138.20	136.45	5	10	3.56	5.69
CAPD	11.38	11.96	8	8	1.21	1.43	9.71	10.65	5	10	0.97	0.91
CSID	10.07	10.41	8	8	1.08	1.36	8.85	8.50	5	10	1.02	0.67
C1	11.20		12	1.16		10.87		8	1.76			
XC2	37.16		12	2.81		33.82		8	1.34			
XC3	13.12		11	1.13		11.49		8	0.60			
XC4	12.74		10	1.01		11.90		8	1.09			
XC5	12.50		8	1.02		11.57		10	0.68			
XC6	12.49		13	0.69		11.33		11	0.66			
XC7	13.79		12	0.47		12.97		10	1.35			
XT1	16.22		11	1.09		15.33		7	1.02			
XT2	18.25		13	1.03		17.03		8	1.03			
XT3	18.37		13	0.86		17.31		8	0.73			
XT4	18.83		11	1.03		18.08		9	0.68			
XT5	19.76		12	1.49		18.63		8	0.40			
XT6	20.67		13	1.46		19.02		6	0.82			
XT7	21.08		13	0.90		19.65		7	0.54			
XT8	21.55		14	1.03		20.06		7	1.28			
XT9	21.72		13	0.93		20.56		7	0.88			
XT10	22.22		12	1.18		20.89		7	0.56			
XT11	22.57		12	0.93		21.64		9	1.39			
XT12	24.33		13	1.37		23.46		9	1.07			
XL1	25.84		14	1.09		25.31		11	1.36			
XL2	26.02		15	1.42		25.78		11	1.11			
XL3	26.61		15	1.81		26.36		11	1.69			
XL4	27.38		15	1.20		27.15		11	1.71			

NEED 1, CONTINUED

Dimension	MALES						FEMALES					
	Mean		<i>n</i>		Std. Dev.		Mean		<i>n</i>		Std. Dev.	
	left	right			left	right	left	right			left	right
XL5	28.15		15		1.48		28.19		11		2.27	
S1	31.14		10		1.44		29.67		11		2.34	
SML	118.22		5		18.60		111.39		9		9.81	
HML	314.86	322.18	11	11	17.40	13.91	294.14	296.50	11	7	13.46	8.15
HEB	61.50	62.17	13	12	3.36	3.16	53.82	54.00	11	9	1.95	2.76
HHD	45.54	46.58	10	10	2.67	2.08	40.26	39.83	11	8	2.00	1.84
HMLD	20.39	21.96	12	12	1.59	2.14	17.72	17.82	11	9	0.98	1.13
HAPD	20.51	21.49	12	12	1.56	1.85	18.32	17.99	11	9	1.39	1.19
HAB	44.74	44.39	13	12	1.93	2.06	39.52	39.52	11	9	1.98	1.56
RML	245.00	248.13	9	12	11.92	12.17	222.86	232.50	7	7	8.38	6.36
RMLD	14.34	14.75	9	12	1.49	1.23	13.36	13.23	9	9	1.96	1.30
RAPD	11.61	12.22	9	12	0.85	0.77	10.46	10.19	9	9	1.32	0.33
RMLH	21.72	21.66	8	11	2.04	1.30	19.98	19.72	8	8	1.11	1.02
RAPH	22.32	22.55	8	10	2.07	1.51	20.61	20.42	8	8	1.10	0.94
RAB	25.58	26.05	10	11	1.69	1.38	23.25	23.54	9	7	0.90	0.93
UML	263.89	270.91	9	11	11.45	14.81	245.50	248.60	10	5	10.34	6.80
UMLD	13.11	13.36	9	11	0.99	0.81	10.99	11.02	10	6	1.24	0.94
UAPD	15.50	15.93	9	11	0.87	1.48	13.50	12.44	10	6	1.23	0.65
FML	443.29	447.07	12	7	17.43	17.66	418.14	416.83	7	9	21.76	19.09
FBL	442.09	435.75	11	6	14.37	13.99	413.14	413.00	7	8	21.33	18.86
FEB	81.25	81.77	10	11	4.10	2.98	72.78	73.38	9	8	2.53	3.10
FAB	70.59	71.07	11	11	3.45	2.70	63.56	62.95	9	10	1.82	2.82
FHD	45.94	45.83	13	9	2.67	1.69	40.39	40.63	10	11	1.77	1.77
FMLD	26.28	26.88	12	9	1.49	1.41	24.12	23.85	8	9	1.55	1.20
FAPD	29.37	29.22	12	9	2.30	2.37	24.28	24.71	8	9	1.77	1.99
TML	375.75	377.46	10	12	15.94	21.05	346.85	350.50	10	8	17.55	17.88
TFL	372.05	373.79	10	12	15.70	20.81	343.80	346.35	10	8	17.18	18.15
TPB	76.32	77.50	11	8	2.97	3.40	67.39	68.56	9	9	2.38	2.99
TPAB	73.88	75.67	11	8	3.01	3.19	65.62	66.21	9	9	2.28	2.81
TMLD	21.24	23.46	11	13	1.54	1.55	19.20	20.51	10	10	2.48	1.22
TAPD	29.48	29.16	11	13	2.40	1.91	24.90	23.91	10	9	2.50	1.55
FIML	360.50	364.42	7	6	5.61	13.89	328.57	347.67	7	6	16.90	25.03
BIB	280.17		9		14.59		261.40		10		9.67	
IBL	152.57	154.50	7	8	6.05	8.28	146.00	146.50	9	10	6.58	6.10
ACH	50.52	50.03	12	11	2.20	2.41	45.28	44.67	11	11	2.01	1.71
TCH	65.80	66.56	5	8	1.99	3.41	58.50	60.88	5	4	2.76	1.65
TTB	30.64	30.78	5	10	1.10	1.27	28.11	29.02	5	4	1.68	1.23

POINT SAL

Dimension	MALES						FEMALES					
	Mean		n	Std. Dev.		Mean		n	Std. Dev.			
	left	right		left	right	left	right		left	right		
BBH	138.36		14	3.32		132.00		7	4.20			
GBL	183.29		14	4.86		174.14		7	2.91			
EUB	139.57		14	4.07		138.86		7	3.98			
UFH	82.36		12	3.16		78.02		6	4.00			
NAH	28.63		7	2.53		26.47		6	1.86			
NAW	23.52		11	1.91		22.62		7	1.97			
ZYG	139.92		13	4.48		135.86		7	5.49			
JNB	27.03		2	1.46		20.29		1				
CML	156.83	147.00	3	3	8.81	15.52	129.50	136.00	1	1		
CAPD	12.60	11.54	3	3	0.62	1.17	10.82	9.84	1	1		
CSID	10.03	8.95	3	3	0.83	0.35	7.93	8.06	1	1		
C1	10.58		6	0.59		9.63		1				
XC2	35.73		5	0.82		32.88		1				
XC3	11.95		5	0.91		11.52		1				
XC4	11.70		4	1.62								
XC5	10.75		5	1.49								
XC6	10.55		6	1.37		12.09		1				
XC7	12.78		6	0.91		13.61		2	0.81			
XT1	15.15		4	0.41		14.89		2	0.61			
XT2	17.32		5	0.92		15.60		2	0.41			
XT3	17.82		4	1.55		15.36		1				
XT4	18.04		5	0.95		16.32		1				
XT5	18.38		3	1.58		16.40		1				
XT6	19.07		3	2.70		16.31		1				
XT7	19.79		5	2.01								
XT8	20.52		4	2.72								
XT9	21.78		4	1.97		20.29		2	0.70			
XT10	21.24		4	2.04		20.78		2	0.75			
XT11	21.62		5	1.37		20.73		2	0.18			
XT12	23.06		5	0.86		22.24		2	0.41			
XL1	24.50		8	0.84		24.36		2	1.49			
XL2	23.40		6	1.94		24.25		1				
XL3	24.96		6	0.86		24.31		1				
XL4	25.78		6	1.73		25.58		1				

POINT SAL, CONTINUED

Dimension	MALES						FEMALES					
	Mean		<i>n</i>		Std. Dev.		Mean		<i>n</i>		Std. Dev.	
	left	right			left	right	left	right			left	right
XL5	26.87		7		2.11		26.07		2		0.98	
S1	27.87		6		2.77		27.87		3		2.76	
SML	104.20		6		11.27		106.84		3		9.59	
HML	312.73	316.75	11	8	10.19	12.23	280.13	293.88	4	4	5.98	30.37
HEB	57.09	56.61	11	9	2.42	3.42	50.00	52.38	3	4	2.00	4.71
HHD	43.15	42.73	9	6	2.06	1.92	37.68	39.32	4	4	2.45	3.69
HMLD	19.94	20.56	11	8	1.17	0.99	17.63	18.15	4	4	1.80	1.55
HAPD	19.09	20.30	11	8	1.03	1.39	17.98	18.80	4	4	2.10	1.82
HAB	41.97	42.77	10	9	2.48	2.55	37.08	38.00	3	4	1.74	2.56
RML	240.44	244.80	8	5	8.96	5.85	223.00	217.00	2	2	0.00	2.83
RMLD	13.01	13.79	8	5	2.27	0.30	13.28	12.51	2	2	0.10	1.58
RAPD	11.60	12.40	8	5	0.78	0.47	10.70	10.52	2	2	0.33	0.95
RMLH	21.18	21.29	8	5	1.54	1.12	19.13	19.44	2	2	0.06	0.59
RAPH	22.23	22.38	8	5	1.37	1.24	19.91	19.57	2	2	0.35	0.04
RAB	24.81	26.32	7	4	1.02	0.93	22.15	21.90	2	2	0.88	0.17
UML	260.39	260.30	9	5	10.23	9.83	240.00	238.00	1	2		5.66
UMLD	12.22	12.27	9	6	1.33	0.72	11.02	11.46	1	2		2.13
UAPD	13.95	13.94	9	6	1.07	0.86	12.03	12.15	1	2		0.16
FML	425.96	426.77	11	11	15.72	13.45	385.00	389.67	5	3	15.11	11.24
FBL	424.61	423.60	9	10	16.34	13.49	381.80	384.67	5	3	15.34	12.58
FEB	77.83	79.06	9	9	1.75	2.17	71.67	70.50	3	4	2.75	3.11
FAB	70.43	70.29	9	10	2.45	3.87	63.06	61.26	4	4	2.99	1.67
FHD	43.85	44.42	10	11	1.58	1.07	40.26	39.00	6	3	2.63	0.60
FMLD	24.35	25.30	12	11	0.88	1.95	23.13	23.01	5	3	1.00	0.98
FAPD	30.33	30.55	12	11	1.91	1.77	26.85	26.74	5	3	2.70	1.22
TML	362.33	366.61	9	9	12.93	21.72	324.50	329.00	4	3	14.58	11.30
TFL	358.78	363.70	9	9	12.69	21.15	321.50	325.61	4	3	14.40	11.26
TPB	75.44	76.69	8	8	2.48	3.63	65.88	67.50	4	3	3.73	3.50
TPAB	73.26	74.93	8	8	2.69	3.09	64.49	65.78	4	3	3.53	3.73
TMLD	21.23	23.56	9	10	1.47	2.34	18.67	19.78	4	3	1.79	0.81
TAPD	29.66	28.07	9	10	1.69	3.11	24.71	23.94	4	3	1.46	1.49
FIML	341.25	342.83	4	3	3.86	5.20	314.50	300.00	2	1	17.68	
BIB	262.67		6		10.76		251.88		4		20.14	
IBL	145.20	147.67	5	6	4.82	4.13	143.20	142.17	5	6	7.36	7.99
ACH	50.34	49.00	5	6	1.15	1.52	46.18	46.58	5	4	3.04	3.62
TCH	62.75	65.92	2	6	6.72	4.36	59.25	58.50	2	1	4.60	
TTB	29.68	30.05	4	7	0.97	0.96	27.02	27.16	1	1		

RYAN MOUND

Dimension	MALES						FEMALES					
	Mean		n	Std. Dev.		Mean		n	Std. Dev.			
	left	right		left	right	left	right		left	right		
BBH	136.63		35	4.94		131.21		34	4.92			
GBL	179.43		35	4.83		172.29		34	4.98			
EUB	136.80		35	4.28		133.94		34	3.64			
UFH	80.94		35	4.91		76.76		34	3.97			
NAH	29.32		32	2.75		26.90		33	1.79			
NAW	24.47		38	1.54		24.14		36	1.42			
ZYG	137.78		37	4.72		130.82		34	4.78			
JNB	31.29		28	3.58		26.74		32	3.08			
CML	147.20	145.87	32	37	8.30	7.77	132.89	131.61	33	35	6.76	6.32
CAPD	11.33	11.58	32	37	1.02	0.98	9.81	10.02	33	35	0.69	0.79
CSID	9.53	9.75	32	37	1.00	1.00	8.50	8.73	33	35	0.81	0.99
C1	11.34		34	1.12		10.24		32	1.18			
XC2	36.35		31	2.01		34.13		32	1.61			
XC3	12.52		31	1.00		11.62		32	0.72			
XC4	11.96		32	0.81		11.55		29	0.76			
XC5	11.58		30	1.15		11.33		27	1.10			
XC6	12.07		33	0.75		11.62		33	0.93			
XC7	13.81		33	0.92		13.09		30	0.89			
XT1	16.11		35	1.01		15.01		33	0.88			
XT2	17.99		36	1.10		16.73		34	0.91			
XT3	18.28		36	0.76		17.21		34	0.87			
XT4	18.69		37	0.73		17.70		34	0.88			
XT5	19.19		37	0.66		18.39		37	0.81			
XT6	20.09		37	0.89		18.94		38	0.78			
XT7	20.50		37	0.87		19.57		39	0.70			
XT8	21.10		38	0.98		19.91		39	0.68			
XT9	21.69		38	0.89		20.33		39	0.74			
XT10	22.32		39	0.80		20.84		37	0.86			
XT11	22.72		37	0.93		21.51		38	0.82			
XT12	24.08		37	0.98		23.59		38	0.97			
XL1	25.48		39	1.15		25.03		39	0.95			
XL2	25.70		39	1.30		25.49		37	0.88			
XL3	26.16		39	1.26		26.08		38	1.03			
XL4	27.01		40	1.48		26.83		37	1.26			

RYAN MOUND, CONTINUED

Dimension	MALES						FEMALES					
	Mean		n		Std. Dev.		Mean		n		Std. Dev.	
	left	right			left	right	left	right			left	right
XL5	27.52		40		1.64		26.91		37		1.77	
S1	30.10		39		2.57		28.96		38		1.80	
SML	115.03		35		10.32		106.89		31		8.18	
HML	310.13	315.67	34	36	11.82	13.68	288.82	292.93	36	34	11.72	12.03
HEB	58.88	59.46	36	39	2.39	2.17	52.23	52.82	37	36	2.55	2.47
HHD	44.72	45.54	33	36	2.02	2.14	39.15	39.92	37	36	1.68	1.49
HMLD	20.53	21.07	36	39	1.49	1.94	18.10	18.19	38	38	1.35	1.41
HAPD	20.04	21.03	36	39	1.34	1.43	18.22	18.85	38	38	1.20	1.34
HAB	43.71	43.86	36	39	1.89	1.87	39.06	39.23	36	36	1.79	1.57
RML	243.30	244.24	38	36	9.50	9.26	218.40	221.81	31	31	9.09	10.91
RMLD	14.35	14.79	39	38	1.48	1.31	12.98	12.97	36	34	1.03	1.14
RAPD	11.56	11.96	39	38	0.59	0.69	10.30	10.35	36	34	0.79	0.74
RMLH	21.95	22.02	37	38	0.91	1.10	19.69	19.77	32	32	0.84	0.99
RAPH	22.61	22.87	38	37	1.16	1.12	20.37	20.39	31	33	0.78	0.95
RAB	25.91	26.09	38	36	1.36	1.24	23.09	23.49	34	32	1.01	1.12
UML	261.93	264.09	38	33	9.81	9.55	237.96	240.86	33	28	9.83	11.33
UMLD	12.98	13.04	38	38	0.97	0.94	11.22	11.44	35	31	0.74	0.81
UAPD	15.05	15.17	38	38	1.25	1.48	13.42	13.93	35	31	1.07	1.21
FML	435.82	436.18	37	37	16.31	15.90	408.90	405.88	35	36	15.43	12.52
FBL	431.74	431.56	37	36	16.41	15.48	404.20	400.83	35	36	15.05	11.77
FEB	79.80	80.31	37	34	3.03	3.04	71.31	71.68	34	38	2.46	2.40
FAB	70.62	70.96	37	36	2.94	3.04	63.00	63.14	36	39	2.12	2.55
FHD	44.70	44.67	39	36	2.07	2.24	40.07	40.02	37	36	1.45	1.20
FMLD	25.94	26.34	38	38	1.31	1.50	24.43	24.51	37	36	1.49	1.53
FAPD	28.38	28.61	38	38	1.71	1.96	24.89	24.94	37	36	1.43	1.33
TML	363.47	365.91	37	35	13.44	13.89	338.77	338.15	31	37	13.24	13.23
TFL	359.86	362.09	37	35	13.50	13.96	335.52	334.92	30	37	13.44	12.96
TPB	75.88	76.52	34	31	2.64	2.79	67.56	67.84	31	37	2.53	2.49
TPAB	73.63	74.25	34	33	2.72	2.75	66.10	66.28	31	37	2.48	2.12
TMLD	20.69	22.39	37	36	1.24	1.44	19.28	20.13	31	37	1.43	1.32
TAPD	28.82	27.79	37	36	1.90	1.71	24.49	24.08	31	37	1.70	1.72
FIML	349.19	348.98	31	29	14.02	13.92	324.64	323.27	29	32	13.69	14.21
BIB	269.47		37		15.22		266.19		36		11.41	
IBL	151.79	151.52	29	29	6.40	5.98	145.70	144.79	33	33	6.24	6.32
ACH	49.89	49.56	35	38	2.37	2.54	45.54	44.91	37	35	1.82	1.45
TCH	65.29	67.23	36	31	3.09	3.19	58.16	59.78	31	32	2.80	2.28
TTB	30.57	30.70	36	34	1.54	1.65	27.74	28.06	33	36	1.22	1.33

WESTERN BERKELEY

Dimension	MALES					FEMALES						
	Mean		n	Std. Dev.		Mean		n	Std. Dev.			
	left	right		left	right	left	right		left	right		
BBH	147.25		4	4.50		140.00		3	1.00			
GBL	188.80		5	2.86		180.00		3	2.00			
EUB	140.20		5	4.60		138.33		3	3.51			
UFH	83.77		4	5.33		79.06		3	7.72			
NAH	27.38		1			28.85		2	3.13			
NAW	22.79		5	1.40		23.02		3	1.02			
ZYG	141.50		4	3.70		134.00		3	3.46			
JNB	30.35		4	2.69		26.43		1				
CML	148.63	141.67	4	3	4.64	12.74		134.75		2		6.72
CAPD	12.21	12.63	4	3	0.71	0.49		11.92		2		1.57
CSID	10.10	12.10	4	3	0.27	1.16		9.01		2		1.22
C1	10.94		4	1.59		11.56		2	2.97			
XC2	38.33		5	1.90		39.93		1				
XC3	13.22		5	0.99		12.86		1				
XC4	12.40		3	1.05		12.02		1				
XC5	12.87		3	0.53		11.97		1				
XC6	13.53		3	1.66		13.09		1				
XC7	14.55		4	0.35		13.53		1				
XT1	16.27		4	0.78		14.61		1				
XT2	18.45		4	0.45		17.18		2	0.18			
XT3	18.81		4	1.15		17.26		2	0.23			
XT4	19.26		3	1.44		17.85		2	0.53			
XT5	20.12		3	1.59		18.77		2	0.94			
XT6	20.18		4	0.62		19.94		3	1.24			
XT7	21.53		4	1.22		20.35		3	0.52			
XT8	22.03		5	1.14		20.93		3	1.41			
XT9	23.06		6	0.80		20.77		3	2.09			
XT10	23.02		6	1.31		21.31		4	0.77			
XT11	23.60		7	0.97		22.60		4	1.60			
XT12	25.21		7	1.45		24.32		4	1.63			
XL1	25.51		7	2.13		25.44		4	1.68			
XL2	25.86		7	2.08		25.02		4	1.45			
XL3	26.58		7	1.34		24.50		3	1.01			
XL4	27.50		7	0.97		25.41		3	0.91			

WESTERN BERKELEY, CONTINUED

Dimension	MALES						FEMALES					
	Mean		n	Std. Dev.		Mean		n	Std. Dev.			
	left	right		left	right	left	right		left	right		
XL5	27.92		7	1.11		26.16		4	1.26			
S1	30.70		6	2.60		29.05		3	2.26			
SML	114.36		4	7.64		115.73		3	10.34			
HML	319.70	320.93	5	7	7.19	8.45	294.75	301.75	2	4	14.50	17.86
HEB	62.42	62.71	6	7	1.36	1.65	57.00	55.75	2	4	1.41	3.40
HHD	46.89	47.09	3	7	2.05	2.39	41.43	41.91	2	4	3.76	2.81
HMLD	22.13	22.50	6	7	1.31	2.14	19.68	20.24	3	4	0.35	0.82
HAPD	21.45	22.15	6	7	1.30	.43	21.07	20.50	3	4	0.86	0.80
HAB	45.06	44.80	6	7	1.66	2.52	40.85	40.51	2	4	0.83	1.96
RML	246.70	248.10	5	5	10.71	13.41	226.83	232.00	3	1	6.25	
RMLD	15.19	15.90	7	6	1.10	1.16	13.85	14.52	3	3	0.21	1.12
RAPD	12.28	12.37	7	6	.98	.62	11.32	11.14	3	3	0.96	0.84
RMLH	21.46	22.04	5	6	1.59	1.35	19.50	19.20	3	3	1.48	0.48
RAPH	22.77	23.25	5	6	1.12	1.59	20.14	20.05	3	3	1.43	0.81
RAB	26.00	26.60	5	6	1.57	1.81	23.83	23.81	3	3	1.70	1.66
UML	275.75	271.00	4	6	8.66	13.25	247.75	247.00	4	2	5.91	8.49
UMLD	13.27	14.15	5	6	1.31	.90	11.90	12.59	4	4	0.90	0.87
UAPD	16.05	16.39	5	6	1.63	1.04	15.24	15.41	4	4	1.28	1.34
FML	454.00	447.83	5	6	17.42	9.41	423.13	433.33	4	3	26.99	20.21
FBL	450.70	444.25	5	6	18.81	10.58	429.50	430.00	3	3	22.75	22.27
FEB	81.80	82.30	5	5	2.51	3.80	73.83	75.67	3	3	4.25	4.93
FAB	73.24	72.63	5	3	2.80	1.49	66.43	66.72	3	3	2.46	2.33
FHD	46.69	46.62	5	6	1.90	2.19	42.46	43.09	4	3	2.82	3.05
FMLD	27.61	27.19	5	6	.84	1.17	26.34	26.84	4	3	2.76	2.41
FAPD	28.79	28.58	5	6	1.85	1.50	27.43	28.22	4	3	1.50	1.78
TML	387.30	376.25	5	6	10.24	12.31	352.33	360.00	3	2	25.15	28.28
TFL	382.70	372.53	5	6	10.51	11.37	347.17	355.50	3	2	24.67	26.16
TPB	76.63	78.90	4	5	1.49	2.36	69.00	73.50	2	1	3.54	
TPAB	75.85	77.50	4	5	1.69	2.22	68.04	72.35	3	1	4.44	
TMLD	21.83	24.08	5	6	1.18	1.55	20.48	22.96	3	2	0.36	2.63
TAPD	31.28	29.47	5	6	1.73	1.82	27.30	25.27	3	2	0.75	0.10
FIML	369.17	361.50	3	3	8.78	11.50	354.00	352.00	1	1		
BIB	281.90		5		4.51		268.00		3		5.29	
IBL	160.00	159.00	5	6	6.04	6.29	143.00	159.50	1	2		6.36
ACH	51.70	51.21	5	6	2.15	2.78	46.85	49.39	4	2	2.14	1.10
TCH	67.00	67.83	4	6	1.47	2.77	62.67	66.00	3	3	4.62	2.65
TTB	31.90	31.79	5	6	1.54	1.37	30.11	30.60	4	4	0.86	1.53

YERBA BUENA (AND CENTRAL BAY AREA)

Dimension	MALES						FEMALES					
	Mean		n	Std. Dev.		Mean		n	Std. Dev.			
	left	right		left	right	left	right		left	right		
BBH	138.86		7	3.48		128.00		2	1.41			
GBL	185.43		7	6.24		180.50		2	7.78			
EUB	137.14		7	2.73		132.00		2	0.00			
UFH	80.09		7	3.96		77.44		2	5.54			
NAH	29.29		4	3.01		24.92		2	1.27			
NAW	22.79		6	1.55		21.94		2	2.59			
ZYG	139.29		7	2.63		131.50		2	4.95			
JNB	30.91		5	3.61		27.10		2	1.28			
CML	144.40	144.75	5	6	2.33	3.95	135.50	134.75	2	2	2.83	0.35
CAPD	11.27	12.69	5	7	0.63	1.44	11.03	11.36	2	2	0.00	0.36
CSID	9.96	10.91	5	7	1.04	1.47	8.99	10.00	2	2	1.00	0.78
C1	10.76		5	0.75		10.98		2	1.12			
XC2	35.88		7	4.56		35.30		2	2.88			
XC3	12.07		7	1.39		11.28		2	1.02			
XC4	11.22		7	1.01		10.95		2	0.25			
XC5	10.82		6	1.69		11.16		2	1.02			
XC6	11.63		8	1.49		11.26		2	0.01			
XC7	13.66		8	1.04		13.41		2	0.39			
XT1	15.82		7	0.89		16.01		2	1.42			
XT2	18.20		7	0.76		17.64		2	1.09			
XT3	18.60		7	0.91		18.29		2	0.24			
XT4	18.49		8	1.36		18.30		2	0.18			
XT5	19.74		7	0.85		18.47		2	0.26			
XT6	20.01		7	0.89		19.64		2	0.59			
XT7	20.73		8	0.49		20.29		2	0.60			
XT8	21.03		7	0.70		21.38		2	1.24			
XT9	21.59		7	1.28		21.10		2	0.42			
XT10	22.02		7	1.15		21.42		2	0.45			
XT11	22.44		7	0.70		21.22		1				
XT12	23.75		7	0.75		24.41		1				
XL1	24.95		8	0.90		23.64		2	3.32			
XL2	26.00		8	0.76		25.80		2	1.40			
XL3	25.95		8	0.90		26.52		2	0.85			
XL4	26.65		8	1.26		26.65		2	1.20			

YERBA BUENA (AND CENTRAL BAY AREA), CONTINUED

Dimension	MALES						FEMALES					
	Mean		n	Std. Dev.		Mean		n	Std. Dev.			
	left	right		left	right	left	right		left	right		
XL5	27.34		8	1.01		25.17		2	1.02			
S1	30.00		8	1.64		28.27		2	1.03			
SML	109.22		5	13.65		110.53		1				
HML	311.19	310.86	8	7	13.38	12.23	301.25	304.25	2	2	3.89	5.30
HEB	59.56	59.67	8	6	2.68	2.79	54.00	54.00	1	2		2.83
HHD	44.94	46.04	8	7	2.40	2.23	42.59	41.66	2	2	0.87	1.53
HMLD	21.34	23.37	8	7	2.34	2.98	22.20	21.75	2	2	1.12	1.38
HAPD	20.84	22.15	8	7	2.13	2.07	19.21	19.68	2	2	0.37	1.61
HAB	44.51	43.96	8	5	1.68	1.39	41.59	40.66	1	2		1.87
RML	248.81	249.07	8	7	14.96	13.13	236.00	238.25	2	2	4.24	6.01
RMLD	14.32	14.97	8	7	1.37	1.63	13.26	13.46	2	2	0.40	0.28
RAPD	11.81	12.21	8	7	0.76	0.91	11.27	11.42	2	2	0.37	0.37
RMLH	22.09	22.34	7	7	1.24	0.97	20.78	20.84	2	1	0.62	
RAPH	22.96	22.95	7	7	1.28	1.16	21.35	20.76	2	2	0.41	0.59
RAB	25.43	25.78	8	7	1.49	1.60	24.77	24.55	1	2		0.87
UML	268.44	268.38	8	8	13.73	11.98	260.00	263.00	1	1		
UMLD	12.80	13.67	8	8	0.97	1.26	11.07	11.43	1	1		
UAPD	15.34	16.04	8	8	1.46	1.28	14.05	15.24	1	1		
FML	443.25	442.29	8	7	29.28	20.33	422.00	432.00	1	1		
FBL	443.38	437.50	8	7	24.51	19.75	416.00	426.50	1	1		
FEB	81.67	81.14	6	7	3.52	2.81	76.50	75.50	2	1	2.83	
FAB	71.67	72.56	7	7	1.60	2.09	66.56	65.60	2	1	2.09	
FHD	45.70	45.65	8	7	2.95	2.86	43.60	44.38	1	1		
FMLD	26.32	26.13	8	7	1.28	1.75	26.88	25.65	2	1	1.13	
FAPD	31.19	31.16	8	7	1.93	1.38	27.95	28.47	2	1	1.22	
TML	373.31	374.38	8	8	15.49	16.10	361.25		2		7.42	
TFL	371.06	372.06	8	8	15.37	15.92	357.14		2		6.87	
TPB	77.56	77.20	8	5	3.09	2.20	72.50		2		2.12	
TPAB	75.28	75.48	8	5	2.82	2.01	68.64		2		0.54	
TMLD	21.67	24.10	8	8	0.79	1.19	21.50		2		0.19	
TAPD	30.22	28.57	8	8	1.39	0.54	24.68		2		1.20	
FIML	360.63	349.80	8	5	16.26	10.42						
BIB	277.83		6		16.48		273.00		2		1.41	
IBL	156.14	156.20	7	5	3.93	7.29	150.00	154.00	1	1		
ACH	50.28	52.13	6	6	2.58	3.09	48.61	50.66	2	1	0.73	
TCH	66.67	68.00	6	7	1.99	1.38		67.00		1		
TTB	31.64	31.86	6	7	1.89	1.18		30.85		1		

YUMA III

Dimension	MALES						FEMALES					
	Mean		n	Std. Dev.		Mean		n	Std. Dev.			
	left	right		left	right	left	right		left	right		
BBH	133.75		4	3.10		128.75		4	5.56			
GBL	176.75		4	11.44		168.25		4	12.79			
EUB	133.75		4	6.18		139.50		4	6.25			
UFH	79.89		4	4.84		75.12		4	3.16			
NAH	26.87		3	2.93		26.28		3	0.60			
NAW	24.26		4	1.03		24.10		4	0.53			
ZYG	140.25		4	2.87		133.50		4	2.52			
JNB	27.62		1			24.90		2	4.07			
CML	151.67	150.50	3	3	13.58	16.39	134.67	132.00	3	3	3.51	4.58
CAPD	11.66	11.10	3	3	1.02	0.08	11.19	11.17	3	3	1.87	1.44
CSID	10.30	10.50	3	3	1.07	1.11	8.80	9.36	3	3	1.69	1.60
C1	11.89		2	0.91		9.32		2	0.67			
XC2	38.41		2	4.20		34.42		3	1.14			
XC3	13.46		2	1.47		11.22		2	1.26			
XC4	11.40		1			11.07		2	1.49			
XC5	10.53		2	1.07		10.54		1				
XC6	11.95		3	2.04		10.74		2	2.14			
XC7	13.27		3	1.16		12.27		2	2.45			
XT1	15.86		2	0.85		13.14		1				
XT2	17.52		1			16.00		2	1.30			
XT3	17.40		1			16.52		2	0.64			
XT4	18.60		3	0.47		17.00		2	0.88			
XT5	18.76		2	0.54		16.72		1				
XT6	19.52		2	0.52		18.98		2	1.55			
XT7	20.82		1			19.27		3	0.92			
XT8	22.49		1			19.43		2	0.86			
XT9	21.59		3	2.09		19.80		2	0.11			
XT10	22.13		3	2.17		20.25		2	1.24			
XT11	22.08		3	2.15		21.65		2	1.97			
XT12	23.43		3	2.67		22.85		2	2.89			
XL1	24.62		3	3.03		24.58		2	1.99			
XL2	26.05		2	3.80		25.40		2	0.55			
XL3	27.33		2	3.37		25.92		3	1.60			
XL4	28.37		2	3.19		26.40		2	1.44			

YUMA III, CONTINUED

Dimension	MALES						FEMALES					
	Mean		n	Std. Dev.		Mean		n	Std. Dev.			
	left	right		left	right	left	right		left	right		
XL5	28.06		3	3.29		26.82		2	1.31			
S1	39.47		1			28.27		3	2.80			
SML						105.43		2	1.35			
HML	300.50	311.50	2	3	9.19	19.29	282.83	282.00	3	2	8.52	7.07
HEB	58.75	62.00	2	3	2.47	5.29	51.50	53.50	3	1	3.12	
HHD	42.82	46.53	2	3	2.36	4.12	38.94	39.67	3	2	0.40	0.16
HMLD	21.83	23.13	2	3	2.35	2.04	17.62	18.02	3	2	0.46	0.23
HAPD	20.59	22.80	2	3	3.66	2.46	18.35	17.27	3	2	2.25	0.48
HAB	43.02	46.32	2	2	3.00	1.44	37.78	39.56	3	1	1.05	
RML	259.00	282.00	2	1	28.28		221.33	222.00	3	2	5.77	1.41
RMLD	12.93	14.51	2	1	2.21		12.59	12.62	3	2	1.45	2.21
RAPD	10.85	11.85	2	1	1.46		10.12	9.90	3	2	0.86	0.23
RMLH	19.07		1				18.88	18.23	2	1	0.67	
RAPH	19.54		1				19.72	19.60	2	1	0.80	
RAB	25.17	28.54	2	1	5.23		22.87	23.30	3	3	0.66	0.62
UML	270.83	279.75	3	2	18.72	18.74	239.75	241.50	2	2	3.18	0.71
UMLD	12.81	12.90	3	3	1.02	1.01	10.35	10.33	2	2	1.21	0.42
UAPD	13.68	15.02	3	3	1.83	2.10	12.71	13.95	2	2	1.00	1.31
FML	448.75	439.00	2	3	30.76	26.00	398.33	396.83	3	3	10.02	10.61
FBL	444.75	421.50	2	2	31.47	0.71	392.75	390.75	2	2	10.96	11.67
FEB	82.00	86.50	2	2	8.49	0.71	68.00	70.00	1	3		0.87
FAB	71.95	72.66	3	3	5.50	7.20	60.59	61.59	2	2	0.85	1.18
FHD	48.59	45.40	2	2	1.53	3.18	39.85	40.07	2	2	1.86	1.83
FMLD	26.58	26.14	3	3	1.10	1.39	24.18	24.11	3	3	1.24	0.43
FAPD	29.38	29.60	3	3	2.51	3.06	26.46	26.26	3	3	0.90	0.29
TML	378.00	367.00	3	2	20.48	9.90	338.25	333.67	2	3	1.06	8.02
TFL	383.00	363.50	2	2	15.56	12.02	333.50	329.67	2	3	0.71	7.09
TPB	81.75	76.75	2	2	1.77	8.13	67.50	66.00	2	2	0.71	1.41
TPAB	78.24	74.80	2	2	2.16	8.15	64.83	65.38	2	2	1.56	1.56
TMLD	21.18	24.02	3	3	1.77	2.68	17.96	20.47	1	2		1.07
TAPD	29.62	28.61	3	3	3.44	3.75	24.50	24.01	1	2		1.62
FIML	356.50	349.75	2	2	30.41	19.45	319.00	321.25	3	2	3.61	1.77
BIB	276.50		2		26.16		273.67		3		8.50	
IBL	153.00	153.00	1	1			146.00	144.00	3	1	4.36	
ACH	53.71	52.75	1	1			45.58	44.65	3	2	0.91	1.90
TCH	67.50	68.00	1	1			59.50	59.00	2	2	0.71	1.41
TTB	33.98	35.49	1	1			25.83	25.43	2	2	0.00	0.59

ACKMEN / YELLOW JACKET

Dimension	MALES				FEMALES						
	Mean		n	Std. Dev.		Mean		n	Std. Dev.		
	left	right		left	right	left	right		left	right	
BBH	140.60		5	5.55		135.40		5	3.44		
GBL	168.60		5	7.44		151.00		5	2.55		
EUB	151.60		5	6.50		144.00		5	4.30		
UFH	81.69		5	5.87		76.65		6	3.24		
NAH	26.14		5	2.62		24.45		6	2.67		
NAW	25.26		5	1.87		22.98		6	2.12		
ZYG	140.00		4	4.83		131.20		5	7.40		
JNB						22.26		3	3.02		
CML	159.00	157.00	1	1		139.17	137.38	3	4	12.00	9.57
CAPD	11.33	12.26	1	1		9.64	10.34	3	4	0.63	0.39
CSID	10.23	10.71	1	1		8.03	8.05	3	4	0.62	0.55
C1	11.40		1			9.46		4	0.93		
XC2	35.35		1			30.04		4	2.59		
XC3	12.79		1			11.02		4	0.42		
XC4	12.17		1			10.90		3	0.07		
XC5	12.19		1			11.59		4	0.64		
XC6	11.78		1			12.06		4	0.49		
XC7	14.08		1			13.35		4	0.48		
XT1	16.17		2	0.30		14.74		4	0.65		
XT2	17.22		2	1.05		15.85		4	1.10		
XT3	17.40		2	0.63		15.99		4	1.44		
XT4	17.70		2	0.32		16.44		3	0.51		
XT5	17.38		3	0.93		16.97		3	0.94		
XT6	17.79		3	0.90		17.80		4	0.83		
XT7	18.42		2	1.65		18.26		3	0.81		
XT8	18.62		2	1.92		18.85		3	0.13		
XT9	19.16		3	0.81		19.50		3	0.14		
XT10	20.18		3	1.03		20.92		2	1.46		
XT11	20.68		3	0.97		20.81		3	0.85		
XT12	22.35		3	1.52		22.67		3	0.82		
XL1	23.81		3	0.80		24.65		3	0.33		
XL2	24.44		3	0.92		25.35		4	0.80		
XL3	26.02		3	1.02		25.52		4	0.56		
XL4	26.55		3	1.45		26.10		4	1.13		

ACKMEN / YELLOW JACKET, CONTINUED

Dimension	MALES						FEMALES					
	Mean		n	Std. Dev.		Mean		n	Std. Dev.			
	left	right		left	right	left	right		left	right		
XL5	27.49		3	1.80		26.52		4	1.50			
S1	29.06		3	0.91		27.67		4	0.83			
SML	102.88		2	2.60		100.71		3	16.21			
HML	320.25	314.00	2	2	11.67	24.04	289.90	300.83	5	3	17.67	16.16
HEB	59.75	58.00	2	2	1.06	2.12	54.90	53.50	5	3	2.27	3.91
HHD	45.15	42.77	2	2	0.62	0.13	38.04	37.89	5	4	2.31	2.60
HMLD	22.04	22.75	2	2	0.06	0.73	19.61	21.25	5	3	0.65	2.56
HAPD	19.70	21.02	2	2	0.62	2.02	17.32	17.56	5	3	0.54	0.61
HAB	42.82	40.58	2	2	0.23	2.71	38.00	36.93	5	3	2.67	3.47
RML	241.17	244.67	3	3	13.29	11.56	225.25	226.25	4	6	13.98	10.92
RMLD	14.34	14.52	3	3	0.73	0.92	12.74	13.45	4	6	2.41	1.04
RAPD	11.24	11.80	3	3	0.41	0.43	10.37	10.50	4	6	0.36	0.48
RMLH	21.29	20.29	3	3	0.67	1.08	18.74	19.53	4	4	1.71	0.83
RAPH	21.90	20.94	3	3	0.53	0.43	19.52	20.12	4	4	1.44	0.95
RAB	23.93	24.73	3	3	0.54	0.70	23.75	22.92	2	5	0.52	1.23
UML	261.67	252.00	3	1	12.58		245.25	244.33	2	3	21.57	13.16
UMLD	12.84	12.14	3	1	0.52		11.79	12.28	2	3	1.11	0.61
UAPD	14.95	14.15	3	1	0.64		12.01	11.77	2	3	1.74	1.16
FML	447.50	456.00	2	1	14.85		406.30	407.08	5	6	21.69	21.47
FBL	445.00	452.00	2	1	14.14		402.60	403.58	5	6	22.11	21.74
FEB	78.00		2		4.24		68.25	69.70	6	5	3.31	2.28
FAB	69.22		2		3.07		57.76	57.93	6	6	3.14	2.75
FHD	44.69		2		2.33		38.48	38.10	5	6	1.38	1.14
FMLD	25.00	28.77	2	1	2.96		22.93	22.43	5	6	2.42	1.76
FAPD	30.13	30.31	2	1	2.64		24.72	24.38	5	6	0.54	0.89
TML	376.50	377.00	2	2	27.58	25.46	325.00	332.63	1	4		16.48
TFL	372.50	371.50	2	2	26.16	23.33	322.50	327.13	1	4		14.96
TPB	76.50		1				63.50	64.00	4	5	5.12	2.37
TPAB	74.23		1				61.74	62.91	4	5	4.90	2.67
TMLD	22.60	25.15	2	2	0.78	1.46	18.30	19.85	1	4		0.93
TAPD	29.37	29.21	2	2	1.39	0.74	22.95	23.71	1	4		0.91
FIML	375.50		1				317.50	321.75	2	2	6.36	11.67
BIB	279.00		2		1.41		257.75		4		9.11	
IBL	152.00	145.00	2	1	5.66		144.50	142.33	2	3	9.19	8.08
ACH	47.97	51.66	3	1	4.65		43.51	43.90	3	4	1.71	1.14
TCH	65.00	69.00	2	1	2.83		52.00	53.75	1	2		3.89
TTB	30.66	31.86	2	1	1.20		24.21	25.38	1	2		0.09

BAYSHORE MOUNDS

Dimension	MALES					FEMALES						
	Mean		<i>n</i>	Std. Dev.		Mean		<i>n</i>	Std. Dev.			
	left	right		left	right	left	right		left	right		
BBH	136.63		8	3.07		137.46		11	6.02			
GBL	174.50		8	5.10		170.09		11	6.06			
EUB	142.38		8	4.07		137.46		11	2.77			
UFH	83.55		9	5.03		78.88		10	3.02			
NAH	29.53		7	3.35		27.76		8	1.59			
NAW	26.14		9	1.88		24.53		10	1.76			
ZYG	141.22		9	7.08		135.64		11	3.98			
JNB	25.23		1			23.34		3	4.61			
CML	147.00	135.50	1	2		12.02	136.50	137.20	3	5	4.09	3.11
CAPD	15.63	13.78	1	2		2.54	12.59	11.97	3	5	2.49	1.66
CSID	11.72	10.83	1	2		2.38	10.57	10.16	3	5	2.66	1.35
C1	11.82		3	0.69		11.46		5	1.35			
XC2	36.91		3	3.69		36.31		5	2.29			
XC3	11.61		3	0.15		12.08		5	1.05			
XC4	11.59		1			11.53		4	0.71			
XC5	11.81		2	0.19		11.11		4	0.97			
XC6	10.93		1			12.24		6	0.46			
XC7	12.80		1			13.84		6	0.74			
XT1	14.98		2	0.31		15.87		6	1.08			
XT2	17.59		2	0.04		17.59		6	1.02			
XT3	18.54		1			17.61		6	1.08			
XT4						18.53		6	0.63			
XT5						19.00		4	0.35			
XT6	21.23		1			19.50		3	0.57			
XT7	18.85		1			20.76		4	0.78			
XT8	19.67		1			21.34		4	0.75			
XT9	20.22		1			21.64		4	0.53			
XT10	21.15		1			22.43		4	1.12			
XT11	22.27		1			22.99		4	1.57			
XT12	23.61		1			24.20		4	1.54			
XL1	25.09		1			25.23		4	1.15			
XL2	25.46		1			26.27		4	1.06			
XL3	25.86		1			26.62		4	1.07			
XL4	26.25		1			26.47		4	0.86			

BAYSHORE MOUNDS, CONTINUED

Dimension	MALES						FEMALES					
	Mean		n	Std. Dev.		Mean		n	Std. Dev.			
	left	right		left	right	left	right		left	right		
XL5	26.70		1			27.59		4	2.17			
S1	31.37		1			29.52		4	0.41			
SML												
HML	297.33	301.67	3	3	1.15	5.69	305.40	300.38	5	4	11.33	5.15
HEB	59.42	61.38	6	4	2.78	3.68	52.20	52.63	5	4	2.95	2.63
HHD	44.69	45.36	2	3	2.38	1.27	40.04	39.92	5	4	1.19	1.34
HMLD	20.68	24.15	4	3	1.58	2.67	19.99	19.21	5	4	0.92	1.08
HAPD	21.90	23.98	4	3	1.31	2.01	19.84	19.57	5	4	1.10	0.95
HAB	42.28	45.37	6	4	3.14	3.60	36.67	37.83	4	4	1.40	0.73
RML	234.50	253.00	5	2	17.34	16.97	229.20	221.33	5	3	12.26	2.52
RMLD	15.68	17.05	6	3	1.45	1.42	13.45	15.00	5	3	0.87	0.50
RAPD	12.74	13.58	6	3	1.59	1.84	11.77	11.26	5	3	0.43	0.60
RMLH	21.61	21.84	5	4	1.33	2.53	19.45	18.94	4	2	0.34	0.35
RAPH	22.14	22.43	5	4	2.29	2.43	19.27	19.70	4	2	0.90	1.07
RAB	24.48	27.33	4	2	2.53	1.39	23.06	23.57	6	3	0.82	0.96
UML	254.67	282.00	3	2	6.81	11.31	258.50	241.75	2	4	6.36	5.19
UMLD	13.32	16.32	3	2	0.55	0.96	11.23	12.75	2	4	0.83	0.84
UAPD	15.72	17.98	3	2	2.07	0.85	13.48	15.59	2	4	0.61	1.38
FML	420.00	401.00	3	1	17.76		421.10	425.00	5	3	22.08	15.87
FBL	424.00	393.50	2	1	14.14		412.38	415.50	4	2	21.29	17.68
FEB	75.20	80.50	5	1	2.89		71.17	71.63	3	4	2.47	2.50
FAB	65.40	67.95	5	1	2.79		62.26	62.17	3	4	3.54	3.47
FHD	42.64	44.58	3	4	2.66	1.44	40.65	41.11	5	3	0.58	0.63
FMLD	26.25	27.04	3	2	2.15	0.13	24.89	23.92	5	3	1.64	1.58
FAPD	30.42	31.85	3	2	1.64	1.15	26.91	27.19	5	3	2.74	1.22
TML	356.38	349.33	4	3	9.41	15.14	351.67	358.00	3	3	24.58	16.00
TFL	353.38	346.33	4	3	9.56	14.36	348.27	354.08	3	3	24.64	16.00
TPB	68.00	70.50	2	2	1.41	3.54	68.67	67.25	3	2	0.58	1.06
TPAB	66.93	68.97	2	2	0.94	2.38	66.85	66.27	3	2	0.76	0.73
TMLD	23.07	24.39	4	3	0.84	1.05	20.42	22.75	3	3	1.05	5.42
TAPD	26.69	30.43	4	3	1.25	1.19	25.64	26.55	3	3	1.22	5.63
FIML	342.50	329.50	1	2		21.92		341.00		2		29.70
BIB	272.00		1			265.33		3	16.29			
IBL	149.00	150.00	1	1			149.50	150.00	2	2	2.12	2.83
ACH	47.84	50.35	1	2		0.18	46.51	47.56	3	2	0.65	1.77
TCH	62.00	64.50	2	1	0.00		60.00	61.00	2	3	2.83	0.00
TTB	29.37	29.16	2	3	0.59	2.53	27.91	26.12	2	3	1.55	0.76

PALMER

Dimension	MALES					FEMALES						
	Mean		n	Std. Dev.		Mean		n	Std. Dev.			
	left	right		left	right	left	right		left	right		
BBH	141.15		13	4.08		135.19		16	3.31			
GBL	181.39		13	5.38		173.60		15	5.11			
EUB	142.46		13	4.81		137.38		16	4.90			
UFH	81.79		12	5.11		79.56		15	4.18			
NAH	27.76		9	1.58		25.88		13	1.81			
NAW	24.48		12	1.35		23.63		16	1.93			
ZYG	142.58		12	4.78		137.19		16	5.84			
JNB	27.00		6	2.26		26.40		2	0.37			
CML	146.71	146.75	7	8	5.35	7.83	140.10	138.38	10	8	7.06	6.12
CAPD	13.36	13.01	7	8	2.00	1.93	10.77	11.58	10	8	1.29	0.86
CSID	11.77	11.13	7	8	2.76	1.37	8.93	9.65	10	8	0.66	0.95
C1	11.18		11	1.44		10.90		12	1.63			
XC2	36.90		12	2.20		35.67		12	1.64			
XC3	12.33		12	0.93		11.44		12	1.15			
XC4	11.92		10	1.29		11.20		12	0.72			
XC5	11.16		11	0.77		11.09		13	0.98			
XC6	11.72		9	0.57		11.30		13	1.19			
XC7	13.34		9	0.77		12.74		13	0.85			
XT1	15.59		10	0.89		14.75		12	0.52			
XT2	16.99		11	1.02		16.30		12	0.75			
XT3	17.59		10	1.09		16.92		11	0.61			
XT4	18.05		8	0.68		17.28		11	0.73			
XT5	18.58		7	0.64		17.81		12	0.93			
XT6	19.04		7	0.79		18.14		12	0.88			
XT7	19.30		8	0.64		18.71		11	0.94			
XT8	20.33		8	0.57		19.70		11	0.82			
XT9	21.18		8	0.76		20.10		10	1.05			
XT10	21.86		8	0.82		20.78		13	1.18			
XT11	22.27		8	1.53		21.48		13	0.97			
XT12	23.86		8	1.64		23.43		13	1.09			
XL1	24.75		11	1.28		24.92		13	1.31			
XL2	25.06		8	1.47		25.37		12	1.42			
XL3	25.71		9	1.37		25.86		13	1.41			
XL4	26.81		9	1.38		25.94		14	1.31			

PALMER, CONTINUED

Dimension	MALES						FEMALES					
	Mean		<i>n</i>		Std. Dev.		Mean		<i>n</i>		Std. Dev.	
	left	right			left	right	left	right			left	right
XL5	26.68		11		1.61		25.91		14		1.66	
S1	29.30		9		2.10		28.99		12		1.79	
SML	117.47		4		16.72		119.83		3		15.82	
HML	311.38	318.22	8	16	9.64	9.46	297.63	299.30	16	10	11.39	6.16
HEB	58.82	61.50	11	15	3.91	3.28	54.68	56.13	14	12	2.95	2.99
HHD	44.46	45.13	11	14	2.27	1.94	41.12	40.93	13	10	1.82	1.61
HMLD	22.83	24.11	9	15	2.41	2.50	19.08	19.34	16	11	1.92	1.42
HAPD	22.55	24.20	9	16	1.99	2.34	19.81	20.35	16	11	1.37	1.30
HAB	43.16	44.22	11	14	2.42	2.26	38.70	39.21	14	13	2.05	1.66
RML	239.44	241.08	9	12	13.57	10.92	225.59	229.85	11	13	10.85	8.11
RMLD	15.91	16.44	9	12	1.39	0.96	13.45	14.14	11	14	0.98	1.06
RAPD	12.68	13.25	9	12	1.60	1.48	11.24	11.36	11	14	0.79	0.83
RMLH	22.06	21.79	8	11	1.25	1.36	19.39	18.85	11	13	1.05	0.73
RAPH	22.81	22.83	8	11	1.85	1.41	20.12	19.74	11	12	1.42	0.82
RAB	25.27	25.97	8	10	1.84	1.68	23.70	23.80	12	14	1.12	1.47
UML	262.96	264.07	12	7	14.45	13.36	244.04	248.96	14	12	11.45	9.33
UMLD	14.19	14.14	12	7	1.97	1.19	12.41	12.84	14	12	0.90	1.03
UAPD	16.97	17.61	12	7	1.82	1.40	14.51	15.52	14	12	1.01	1.61
FML	448.94	443.05	9	10	13.56	15.29	422.96	417.40	11	10	15.59	14.79
FBL	445.06	438.90	9	10	13.39	15.53	417.73	415.22	11	9	14.97	13.44
FEB	80.04	79.35	12	10	3.92	4.16	73.68	74.09	11	11	2.43	2.64
FAB	70.19	68.88	12	10	3.86	4.30	63.47	64.40	11	11	2.32	2.98
FHD	45.04	45.06	13	14	1.63	1.88	41.65	41.48	15	13	1.72	1.60
FMLD	27.61	27.41	10	11	1.42	1.56	25.91	25.53	11	11	1.16	0.75
FAPD	31.14	30.91	10	11	2.50	3.11	27.54	27.92	11	11	1.38	1.38
TML	366.50	375.06	8	8	9.84	16.94	356.35	354.50	10	11	9.64	11.62
TFL	362.00	370.31	8	8	9.92	17.74	352.60	350.96	10	11	10.04	11.26
TPB	73.86	74.56	7	8	3.41	4.16	68.41	69.14	11	11	1.64	2.68
TPAB	71.38	72.56	7	8	3.88	3.67	66.77	67.54	11	11	1.72	2.14
TMLD	22.37	23.04	8	8	2.93	1.49	20.86	21.46	10	11	1.54	1.74
TAPD	28.96	30.63	8	8	2.97	2.86	26.45	25.65	10	11	1.97	2.13
FIML	354.50	339.00	2	1	19.09		343.25	344.25	4	4	10.81	7.59
BIB	266.60		5		15.58		273.00		9		14.33	
IBL	150.75	150.67	4	3	3.20	3.51	147.88	148.17	8	6	8.77	8.06
ACH	50.49	48.43	7	5	2.14	1.95	46.34	45.58	11	11	1.20	1.71
TCH	63.92	65.67	6	9	3.57	3.73	61.60	62.00	10	9	2.87	1.90
TTB	29.27	29.55	11	11	1.28	1.48	27.55	27.82	13	13	0.90	1.36

TICK ISLAND

Dimension	MALES				FEMALES				
	Mean		n	Std. Dev.	Mean		n	Std. Dev.	
	left right			left right	left right			left right	
BBH									
GBL									
EUB									
UFH									
NAH					27.94	1			
NAW					25.06	1			
ZYG					121.00	1			
JNB					24.28	2	1.32		
CML	166.00		1		144.50	144.00	2	1	2.12
CAPD	15.09		1		9.29	10.11	2	1	0.47
CSID	11.27		1		8.69	8.83	2	1	1.55
C1					11.65		1		
XC2	37.53		2	2.31	31.73		1		
XC3	13.92		2	1.00	12.73		1		
XC4	13.32		2	0.36	12.02		1		
XC5	12.55		2	0.44	11.15		2		0.59
XC6	13.19		1		11.73		2		0.66
XC7	14.12		1		13.70		1		
XT1	16.61		2	0.91	15.99		1		
XT2	17.64		3	0.55	17.09		2		0.55
XT3	17.43		2	0.12	17.69		2		0.23
XT4	17.27		2	1.53	18.09		2		0.85
XT5	18.22		3	1.30	19.45		2		0.24
XT6	18.67		2	0.98	20.17		2		0.34
XT7	18.92		2	1.29	20.25		2		0.19
XT8	20.13		2	0.35	20.88		2		0.42
XT9	20.79		2	0.63	20.85		2		0.15
XT10	21.85		2	0.83	22.15		2		0.12
XT11	21.76		2	0.32	23.97		2		0.65
XT12	23.61		2	0.20	25.16		2		0.17
XL1	24.97		2	1.61	26.35		2		0.31
XL2	25.59		3	1.38	27.24		2		0.49
XL3	26.43		3	1.09	27.25		2		0.53
XL4	27.07		3	0.94	28.76		2		1.00

TICK ISLAND, CONTINUED

Dimension	MALES						FEMALES					
	Mean		n	Std. Dev.		Mean		n	Std. Dev.			
	left	right		left	right	left	right		left	right		
XL5	28.82		3	1.83		29.32		2	1.68			
S1	30.71		3	0.71		31.21		2	1.39			
SML	109.84		1									
HML	316.00	321.67	1	3		4.73	286.25	294.00	2	2	2.47	2.83
HEB	64.00	62.33	1	3		1.15	54.00	52.50	1	2		0.71
HHD	43.92	44.14	2	2	0.06	1.02	40.27	38.10	2	2	0.42	3.42
HMLD	24.90	23.71	1	3		3.03	16.61	16.79	2	2	0.21	0.77
HAPD	24.73	22.43	1	3		1.03	15.94	17.90	2	2	0.15	0.33
HAB	44.05	45.88	1	3		1.39	39.11	39.69	1	2		2.01
RML	255.50	247.50	2	2	0.71	10.61	213.00	216.25	1	2		1.06
RMLD	15.68	15.12	2	2	2.51	0.78	12.04	12.17	1	2		0.35
RAPD	14.75	12.51	2	2	1.15	1.51	10.30	10.22	1	2		0.23
RMLH	22.60	22.19	2	3	0.81	0.71	19.47	19.85	2	2	0.36	0.04
RAPH	22.43	22.96	2	3	1.24	0.93	19.31	20.15	2	2	0.39	1.62
RAB	26.99	27.00	3	2	0.41	0.00	23.18	22.87	1	2		0.51
UML	278.50	270.00	2	1	4.95		232.00	236.00	1	1		
UMLD	13.96	11.44	2	1	1.49		10.62	11.78	1	1		
UAPD	17.41	16.17	2	1	0.18		11.87	11.72	1	1		
FML	429.33	416.00	3	1	24.58		397.00	413.00	1	1		
FBL	425.67	415.00	3	1	24.95		396.00	408.50	1	1		
FEB	78.50	80.50	2	1	4.95		73.00	72.00	1	1		
FAB	68.16	70.71	2	1	5.59		62.30	60.09	1	1		
FHD	44.15	45.11	2	2	2.42	1.15	40.23	39.98	2	2	1.13	0.56
FMLD	25.50	27.10	3	1	2.56		22.07	22.53	1	2		0.35
FAPD	28.62	29.70	3	1	3.55		24.40	24.72	1	2		0.46
TML		371.50		2		20.51	337.00	333.00	2	1	4.24	
TFL		366.25		2		18.74	334.00	329.69	2	1	4.24	
TPB	69.00	72.50	1	2		3.54	64.00	67.00	1	1		
TPAB	68.16	44.99	1	2		31.82	63.55	66.41	1	1		
TMLD		24.67		2		7.38	18.82	18.59	2	2	0.49	0.45
TAPD		29.90		2		0.04	24.50	25.10	2	2	2.86	0.21
FIML		370.00		1				328.50		2		4.95
BIB	256.00		2		5.66		264.00		1			
IBL	147.00	148.50	2	2	1.41	0.71	143.50	143.00	2	2	4.95	1.41
ACH	49.97	45.10	2	2	0.37	6.97	45.32	45.29	2	2	2.45	1.28
TCH	65.75	67.00	2	1	2.47		62.00	64.00	1	1		
TTB	28.77	29.90	3	2	1.73	0.28	27.27	27.20	1	1		

WINDOVER

Dimension	MALES						FEMALES					
	Mean		n	Std. Dev.		Mean		n	Std. Dev.			
	left	right		left	right	left	right		left	right		
BBH	137.67		36	4.67		133.86		29	5.94			
GBL	183.05		37	4.91		174.57		30	5.44			
EUB	135.24		37	4.36		129.93		30	4.86			
UFH	79.95		27	3.20		73.55		22	3.81			
NAH	28.79		27	1.99		26.76		22	2.36			
NAW	25.48		32	1.50		24.08		23	1.61			
ZYG	137.71		35	6.05		129.19		26	4.58			
JNB	27.50		8	4.42		22.83		8	2.89			
CML	149.57	147.39	21	23	9.26	7.80	136.07	132.33	15	12	7.75	4.20
CAPD	10.82	11.41	21	23	0.85	1.00	9.23	9.66	15	12	1.16	1.32
CSID	9.36	10.03	21	23	0.89	1.59	8.18	8.40	15	12	0.98	1.05
C1	11.72		33	1.25		9.94		19	1.33			
XC2	35.45		34	2.46		32.06		17	2.63			
XC3	12.36		34	1.15		10.71		17	0.91			
XC4	11.74		32	1.06		10.54		18	0.94			
XC5	11.42		31	1.28		10.33		18	1.01			
XC6	11.90		31	0.93		10.71		18	0.98			
XC7	13.33		30	0.62		12.22		17	0.87			
XT1	15.53		29	0.81		13.97		17	0.80			
XT2	17.00		29	1.15		15.63		16	0.96			
XT3	17.39		31	1.12		16.07		16	1.14			
XT4	18.08		27	1.17		16.64		16	1.17			
XT5	18.85		27	1.30		17.33		14	1.12			
XT6	19.50		29	1.16		17.95		14	1.08			
XT7	20.22		30	1.01		18.59		12	1.40			
XT8	20.63		33	0.97		19.11		13	1.37			
XT9	21.26		32	0.99		19.89		12	1.05			
XT10	21.84		32	1.05		20.21		13	0.89			
XT11	22.43		31	1.14		21.02		14	0.81			
XT12	23.94		29	1.39		22.36		14	1.38			
XL1	25.00		31	1.13		23.22		17	1.39			
XL2	25.11		26	0.83		24.25		15	1.11			
XL3	25.96		26	0.98		24.71		14	1.03			
XL4	27.33		25	1.28		25.35		14	0.91			

WINDOVER, CONTINUED

Dimension	MALES						FEMALES					
	Mean		n		Std. Dev.		Mean		n		Std. Dev.	
	left	right			left	right	left	right			left	right
XL5	28.18		26		1.47		26.41		15		1.46	
S1	30.20		28		2.46		28.27		14		2.16	
SML	110.14		12		8.08		106.08		6		10.61	
HML	314.07	316.55	30	30	14.20	15.63	294.06	293.82	16	19	13.59	15.64
HEB	58.85	59.58	31	32	2.84	3.63	52.78	52.72	18	18	3.30	3.58
HHD	44.23	44.37	30	32	2.40	2.55	38.84	38.80	17	17	2.04	2.53
HMLD	19.61	19.94	30	30	1.48	1.54	17.26	17.15	16	19	1.48	1.76
HAPD	19.07	20.13	30	30	1.37	1.54	17.24	17.27	16	19	1.48	1.49
HAB	41.64	41.38	31	34	2.12	2.35	37.25	36.87	19	19	2.05	2.09
RML	250.52	252.39	30	27	13.36	12.96	226.50	228.10	18	15	12.51	12.73
RMLD	13.04	13.13	30	27	1.15	1.17	12.03	11.79	18	15	1.16	1.17
RAPD	11.11	11.39	30	27	0.88	0.95	10.08	9.80	18	15	0.86	0.62
RMLH	20.71	21.27	32	29	1.47	1.38	18.91	18.61	20	16	1.15	1.04
RAPH	21.59	22.14	32	29	1.56	1.61	19.39	19.12	20	16	1.18	1.42
RAB	24.99	25.44	27	27	1.38	1.53	22.93	22.97	19	18	1.39	1.28
UML	268.02	271.71	27	29	15.29	12.60	246.33	250.13	18	16	12.28	11.77
UMLD	11.94	12.23	27	29	0.85	0.93	10.57	10.67	18	16	0.89	0.89
UAPD	13.94	14.69	27	29	1.21	1.49	12.56	12.83	18	16	1.29	1.10
FML	448.69	449.41	32	32	19.24	19.24	421.03	420.00	18	15	19.84	17.72
FBL	444.34	444.19	31	31	19.86	21.04	414.56	413.75	17	14	20.27	19.14
FEB	78.54	78.67	27	26	4.69	3.95	70.81	72.08	18	12	4.31	4.30
FAB	68.04	68.54	29	28	4.36	4.48	60.98	62.09	18	13	3.15	3.53
FHD	44.78	44.81	36	37	2.53	2.26	40.16	40.09	20	21	2.07	2.10
FMLD	26.46	26.29	32	29	2.09	2.22	23.27	24.21	18	15	2.12	2.11
FAPD	28.14	28.55	32	29	2.94	2.68	23.49	23.64	18	15	1.98	2.07
TML	381.79	380.44	24	27	14.69	16.69	347.93	349.68	15	17	20.58	19.87
TFL	376.95	375.53	24	27	14.60	16.59	343.57	345.74	15	17	20.45	19.24
TPB	73.22	73.46	20	24	4.98	4.53	65.81	66.93	13	15	3.22	3.47
TPAB	70.87	71.41	20	22	5.19	4.00	64.05	64.91	12	15	3.01	3.21
TMLD	19.65	21.17	24	27	1.25	1.76	17.45	18.00	15	17	1.64	1.46
TAPD	26.80	27.40	24	27	2.38	2.21	22.91	23.19	15	17	1.68	1.80
FIML	367.75	363.89	14	18	11.35	12.09	334.08	336.67	12	9	20.92	19.39
BIB	265.42		19		10.93		250.94		8		17.77	
IBL	153.68	154.65	19	17	7.56	7.09	141.70	145.00	10	9	5.87	8.79
ACH	51.22	50.81	28	26	2.59	2.08	44.70	45.46	13	15	1.71	2.32
TCH	65.36	65.79	22	24	3.39	3.40	59.65	60.04	13	12	3.18	4.36
TTB	29.38	29.39	33	30	1.83	1.91	26.60	26.96	14	14	1.37	1.65

IRENE MOUND

Dimension	MALES						FEMALES					
	Mean		n	Std. Dev.		Mean		n	Std. Dev.			
	left	right		left	right	left	right		left	right		
BBH	136.46		11	6.23		130.12		17	6.28			
GBL	178.82		11	7.70		167.35		17	8.09			
EUB	144.30		10	6.45		139.71		17	4.96			
UFH	81.42		10	4.29		76.31		17	4.50			
NAH	28.01		12	2.54		27.43		17	2.77			
NAW	23.81		13	2.68		23.80		17	2.33			
ZYG	137.30		10	8.53		129.29		14	6.53			
JNB	26.03		7	3.41		23.46		8	2.83			
CML	148.80	149.55	10	10	5.59	5.75	133.12	132.00	13	15	6.36	7.96
CAPD	12.08	11.95	10	10	1.95	1.55	9.84	10.54	13	15	1.15	1.72
CSID	10.19	10.01	10	10	1.10	1.44	8.61	9.19	13	15	0.82	1.60
C1	10.94		11	1.66		9.21		14	0.63			
XC2	38.42		13	3.48		34.56		14	2.41			
XC3	13.70		13	1.97		11.97		14	1.32			
XC4	13.23		13	1.71		11.23		13	1.35			
XC5	13.27		13	1.26		11.35		14	1.33			
XC6	13.02		13	1.00		11.82		16	1.39			
XC7	14.46		12	1.30		12.97		16	1.44			
XT1	16.35		12	0.80		15.23		15	1.71			
XT2	17.83		13	1.13		16.06		15	1.05			
XT3	17.91		11	1.69		16.68		15	1.12			
XT4	18.51		10	1.46		17.34		14	1.54			
XT5	19.04		10	1.62		17.88		15	1.48			
XT6	19.72		9	1.56		18.25		15	1.40			
XT7	20.48		9	1.42		18.76		16	1.60			
XT8	20.77		11	1.36		19.27		16	1.47			
XT9	22.04		10	1.47		19.83		15	1.82			
XT10	23.35		9	1.66		20.30		14	1.83			
XT11	23.43		11	1.50		21.52		15	1.67			
XT12	25.28		11	1.88		23.79		15	1.89			
XL1	25.99		13	1.67		25.26		17	2.28			
XL2	26.05		12	2.01		25.93		15	2.00			
XL3	27.29		11	2.14		26.36		15	2.16			
XL4	28.46		12	2.45		26.95		15	2.23			

IRENE MOUND, CONTINUED

Dimension	MALES						FEMALES					
	Mean		n		Std. Dev.		Mean		n		Std. Dev.	
	left	right			left	right	left	right			left	right
XL5	28.53		12		1.88		27.12		16		2.40	
S1	31.21		7		2.95		30.01		15		2.34	
SML	109.30		5		10.44		106.82		7		15.23	
HML	319.17	326.69	9	13	19.74	20.75	298.77	302.58	13	19	16.34	13.97
HEB	60.78	61.35	9	13	3.84	3.68	51.88	51.97	12	16	3.34	3.18
HHD	44.33	44.73	10	13	3.66	3.05	39.66	39.37	14	19	2.29	2.01
HMLD	21.82	21.88	10	13	2.46	1.89	18.69	18.49	14	19	2.07	2.09
HAPD	21.38	22.36	10	13	1.87	1.85	18.71	18.74	14	19	1.57	1.44
HAB	42.90	43.19	9	13	3.73	3.28	37.11	37.34	13	16	1.47	1.68
RML	250.61	255.20	9	10	16.23	12.13	228.04	226.68	14	14	9.58	11.57
RMLD	15.04	15.46	9	10	1.77	1.75	12.76	13.07	15	17	1.52	1.59
RAPD	12.88	12.56	9	10	1.48	0.90	10.41	10.41	15	17	0.85	0.91
RMLH	21.34	21.50	9	10	1.41	2.04	18.56	18.83	14	16	1.01	0.91
RAPH	22.27	21.57	9	10	1.59	2.15	19.31	19.13	14	14	1.22	0.96
RAB	25.25	26.21	9	10	2.53	2.45	23.02	23.05	14	15	1.27	1.18
UML	271.83	271.83	6	9	12.88	12.71	242.27	246.35	11	13	10.21	13.60
UMLD	13.95	13.87	7	12	1.48	0.79	11.20	11.01	11	13	1.08	1.32
UAPD	16.34	15.85	7	12	2.12	1.70	13.39	13.28	11	13	1.12	1.28
FML	452.96	452.75	12	10	28.26	29.38	419.50	420.18	17	17	19.43	18.43
FBL	450.08	448.30	12	10	28.26	29.71	416.41	418.09	17	16	19.41	16.84
FEB	78.18	77.44	11	9	5.47	6.36	69.07	69.75	14	16	3.76	3.61
FAB	68.45	66.91	10	9	4.71	5.31	59.74	59.83	13	15	2.85	3.66
FHD	44.56	44.29	12	10	3.52	4.34	39.61	39.62	19	18	2.53	2.50
FMLD	26.07	26.30	12	10	2.52	2.93	23.20	23.19	17	18	1.69	1.52
FAPD	29.14	29.25	12	10	2.66	2.47	24.81	25.21	17	18	2.45	2.60
TML	382.56	380.19	8	8	15.60	18.35	350.56	351.71	17	17	15.19	14.82
TFL	377.69	376.06	8	8	15.09	17.16	346.53	347.53	17	17	14.88	14.86
TPB	72.79	71.33	7	9	4.61	5.32	63.56	64.08	16	12	2.99	3.78
TPAB	70.71	68.55	8	9	4.36	5.19	61.49	62.21	17	12	3.33	3.76
TMLD	22.48	23.93	8	8	1.60	2.17	19.19	20.45	18	16	2.05	1.71
TAPD	28.88	28.42	8	8	1.36	1.42	24.65	24.54	18	16	2.48	2.10
FIML	372.00	378.50	6	5	7.97	14.07	335.88	332.67	4	6	25.75	21.75
BIB	268.58		6		17.42		253.12		13		9.56	
IBL	159.25	149.00	4	2	12.97	2.83	141.78	143.67	9	9	12.94	11.58
ACH	50.05	50.97	8	7	4.00	3.93	45.18	44.52	12	12	2.54	2.81
TCH	63.73	64.61	11	9	3.36	3.46	57.73	58.59	13	11	3.63	4.01
TTB	28.94	29.12	12	9	1.44	1.46	25.17	25.59	14	13	1.61	1.94

ALBANY MOUNDS

Dimension	MALES						FEMALES					
	Mean		n	Std. Dev.		Mean		n	Std. Dev.			
	left	right		left	right	left	right		left	right		
BBH	140.40		5	5.41		139.17		6	8.18			
GBL	173.50		6	6.80		170.67		6	6.12			
EUB	139.40		5	5.94		135.33		6	7.42			
UFH	81.46		7	4.89		79.53		6	2.82			
NAH	28.80		6	3.55		27.44		5	2.55			
NAW	24.12		8	1.75		24.44		6	0.84			
ZYG	135.83		6	4.54		132.17		6	6.85			
JNB	24.15		3	3.01		24.08		1				
CML	154.42	156.70	6	5	9.11	9.22	141.50	141.33	4	3	3.42	2.25
CAPD	10.39	11.79	6	5	0.76	1.36	9.87	10.25	4	3	2.00	1.46
CSID	9.48	10.92	6	5	1.49	1.64	9.17	9.15	4	3	1.64	0.57
C1	10.97		8	1.04		11.01		4	0.56			
XC2	36.60		6	2.73		34.75		4	1.42			
XC3	13.24		6	1.53		11.88		4	0.71			
XC4	12.29		3	1.20		11.05		2	1.30			
XC5	12.54		3	1.15		12.33		1				
XC6	12.94		4	0.62		12.69		1				
XC7	14.20		4	0.64		14.71		1				
XT1	16.17		2	0.08		15.72		2	1.44			
XT2	17.75		2	0.88		16.97		2	0.38			
XT3	18.09		2	1.29		16.40		2	0.62			
XT4	18.16		2	0.45		17.16		2	0.69			
XT5	18.78		2	0.47		17.61		2	0.30			
XT6	20.06		2	1.43		18.41		2	0.78			
XT7	20.74		2	2.21		18.77		2	0.63			
XT8	22.04		2	1.60		19.23		2	0.20			
XT9	22.02		2	1.12		19.82		2	0.21			
XT10	22.70		2	0.63		20.49		2	0.49			
XT11	23.74		2	0.66		21.62		2	1.24			
XT12	25.67		2	1.75		22.67		2	2.53			
XL1	26.80		2	1.67		25.16		3	0.58			
XL2	27.69		2	0.54		26.72		3	1.24			
XL3	28.60		2	0.37		26.87		2	0.62			
XL4	28.90		2	1.51		27.91		2	2.02			

ALBANY MOUNDS, CONTINUED

Dimension	MALES						FEMALES					
	Mean		<i>n</i>		Std. Dev.		Mean		<i>n</i>		Std. Dev.	
	left	right			left	right	left	right			left	right
XL5	30.01		2		1.34		28.27		3		2.21	
S1	31.03		2		0.98		31.82		3		2.42	
SML	114.63		1				104.06		1			
HML	326.56	333.50	8	7	17.65	12.73	298.71	308.63	7	4	7.70	12.37
HEB	59.50	60.20	8	10	4.05	3.57	53.57	54.20	7	5	2.28	2.84
HHH	44.74	46.38	7	7	2.70	2.69	39.27	39.39	6	4	1.81	1.93
HMLD	19.95	23.50	8	7	1.08	1.32	18.11	18.20	7	4	1.55	2.49
HAPD	19.72	21.31	8	7	1.57	2.42	18.68	19.00	7	4	2.14	2.24
HAB	41.65	43.27	8	10	2.16	3.50	37.85	38.12	7	5	1.87	2.64
RML	232.38	250.14	4	7	13.40	18.17	221.17	219.00	3	2	9.17	5.66
RMLD	14.96	15.42	4	7	0.72	1.32	12.70	11.31	3	2	1.56	0.88
RAPD	12.80	12.94	4	7	1.01	0.54	10.78	9.93	3	2	0.86	0.14
RMLH	21.70	22.00	6	7	1.47	2.10	19.52	19.48	5	3	1.17	0.61
RAPH	22.90	22.84	6	7	1.93	1.62	20.18	20.33	5	2	0.77	0.21
RAB	25.05	25.71	3	6	2.11	1.71	22.96	21.72	3	1	1.66	
UML	268.75	273.93	4	7	16.82	15.66	239.00	239.50	2	2	9.90	8.49
UMLD	14.18	13.96	4	7	1.54	0.84	11.32	10.83	2	2	0.25	0.60
UAPD	15.62	15.38	4	7	1.25	0.99	13.18	12.25	2	2	0.88	0.33
FML	455.56	454.33	8	9	20.24	17.18	430.80	425.43	5	7	12.79	16.67
FBL	451.25	451.06	8	9	19.27	16.60	425.00	420.07	5	7	12.07	14.86
FEB	79.08	80.19	6	8	4.03	3.28	72.00	73.71	5	7	3.45	3.35
FAB	70.81	72.37	6	9	5.02	3.12	64.27	65.62	5	7	2.83	3.37
FHD	45.33	45.58	8	10	2.95	3.00	40.18	41.39	6	7	1.82	1.83
FMLD	26.43	26.09	8	9	1.11	1.27	24.70	23.14	5	7	1.58	1.39
FAPD	28.15	28.01	8	9	2.32	1.98	25.80	24.74	5	7	2.63	2.77
TML	376.28	376.60	9	10	16.49	16.21	351.50	353.00	5	2	12.56	7.07
TFL	371.50	372.21	9	10	16.36	15.37	346.30	350.25	5	2	12.19	7.42
TPB	74.14	75.50	7	8	2.06	2.80	67.67	70.25	6	4	3.31	3.28
TPAB	72.91	74.14	7	8	2.02	2.29	66.48	69.56	6	4	3.18	3.34
TMLD	22.00	23.29	9	9	1.66	1.88	19.37	21.38	5	3	2.19	4.79
TAPD	28.82	28.47	9	9	1.82	1.61	25.04	24.14	5	3	2.26	2.50
FIML	361.70	372.30	5	5	14.27	13.45	333.13		4		10.28	
BIB	255.33		3		10.79		272.00		3		6.93	
IBL	152.43	149.33	7	3	6.02	5.51	147.25	147.67	4	3	7.14	4.16
ACH	50.81	48.68	7	7	3.21	2.44	45.86	47.72	4	4	2.46	2.78
TCH	66.00	66.50	4	3	3.74	3.28	60.33	61.00	3	2	2.89	1.41
TTB	31.08	30.78	4	4	2.06	1.72	27.93	28.10	4	4	1.37	1.24

DICKSON MOUNDS

Dimension	MALES						FEMALES					
	Mean		n	Std. Dev.		Mean		n	Std. Dev.			
	left	right		left	right	left	right		left	right		
BBH	144.08		25	4.31		140.14		21	3.99			
GBL	173.68		25	9.81		168.33		21	5.87			
EUB	143.24		25	9.90		141.62		21	7.63			
UFH	82.79		22	5.27		77.79		16	4.38			
NAH	27.00		18	2.74		27.26		12	3.13			
NAW	24.56		20	2.02		23.90		17	2.10			
ZYG	139.33		24	6.17		132.40		20	4.99			
JNB	26.34		16	3.68		24.77		21	3.22			
CML	155.48	152.82	24	25	9.35	9.46	137.98	138.80	22	23	10.58	8.50
CAPD	11.62	11.84	24	25	1.18	0.92	10.01	10.17	22	24	1.37	1.16
CSID	10.23	10.59	24	25	1.35	1.67	8.65	8.63	22	24	1.15	0.65
C1	11.66		26	0.91		10.61		22	1.15			
XC2	38.76		26	2.71		35.99		22	2.40			
XC3	13.81		26	1.27		12.37		22	0.98			
XC4	13.34		26	1.24		12.43		21	0.95			
XC5	13.34		26	1.23		12.26		22	0.99			
XC6	13.59		26	0.87		12.82		24	0.78			
XC7	14.72		26	1.33		14.24		24	1.05			
XT1	17.20		25	0.76		16.04		23	0.73			
XT2	18.35		26	1.08		17.47		24	0.74			
XT3	18.15		26	0.84		17.42		24	0.70			
XT4	18.72		26	0.92		17.92		24	0.62			
XT5	19.39		26	1.06		18.45		24	0.64			
XT6	20.17		25	1.00		19.08		24	0.81			
XT7	20.79		25	0.99		19.65		25	0.96			
XT8	21.15		25	0.80		20.08		25	0.93			
XT9	21.76		25	1.02		20.54		25	0.97			
XT10	22.38		25	1.20		21.24		25	0.93			
XT11	23.20		25	1.16		21.94		25	1.12			
XT12	25.00		24	1.22		23.95		25	1.32			
XL1	26.54		24	1.25		25.67		25	1.32			
XL2	27.37		25	1.60		26.73		25	1.53			
XL3	27.85		23	1.13		27.43		25	1.53			
XL4	28.97		23	1.35		28.36		26	1.65			

DICKSON MOUNDS, CONTINUED

Dimension	MALES						FEMALES					
	Mean		<i>n</i>		Std. Dev.		Mean		<i>n</i>		Std. Dev.	
	left	right			left	right	left	right			left	right
XL5	29.32		24		1.95		28.89		26		1.64	
S1	31.30		24		1.94		30.85		26		1.75	
SML	111.07		16		9.45		110.39		20		10.12	
HML	327.25	327.38	24	20	12.85	9.86	305.44	304.33	26	21	15.82	14.20
HEB	59.93	59.55	22	20	3.71	4.29	53.60	54.00	24	21	3.11	2.80
HHD	45.26	45.60	25	22	2.39	2.84	40.70	40.00	27	23	2.40	2.45
HMLD	21.95	22.22	23	20	1.65	2.10	19.16	19.83	26	22	1.48	1.76
HAPD	20.47	21.84	24	20	1.38	1.76	19.29	20.17	26	22	1.63	1.40
HAB	42.23	42.03	23	20	2.29	2.38	38.46	38.09	24	20	2.51	2.23
RML	254.59	253.76	23	19	11.49	11.46	233.72	235.55	25	22	11.70	10.55
RMLD	14.84	15.48	23	19	1.49	1.28	14.29	14.72	25	22	1.40	1.59
RAPD	12.49	12.19	23	19	0.85	0.71	11.07	11.10	25	22	0.87	0.84
RMLH	21.56	21.27	22	20	1.51	1.33	19.52	19.74	24	23	1.60	1.50
RAPH	22.31	22.33	21	20	1.37	1.44	20.05	20.43	24	22	1.63	1.48
RAB	25.43	25.08	22	22	1.45	1.59	23.73	23.42	26	24	1.44	1.74
UML	273.55	272.38	22	20	13.47	13.04	250.26	253.75	25	24	11.62	12.89
UMLD	13.51	13.45	22	20	1.25	1.02	11.90	12.15	25	24	0.94	1.15
UAPD	15.61	15.53	22	20	1.68	1.80	14.79	15.06	25	24	1.46	1.54
FML	459.10	455.23	20	24	22.22	18.69	425.11	422.70	27	23	19.59	20.43
FBL	456.35	452.10	20	24	22.25	18.89	420.30	418.30	27	23	19.88	19.98
FEB	79.98	79.82	23	22	4.57	4.62	73.50	73.75	27	24	4.08	4.23
FAB	70.73	70.76	24	22	4.69	4.80	64.24	64.04	27	24	3.65	4.25
FHD	45.97	46.07	25	25	2.05	2.18	41.61	41.51	27	27	2.17	2.06
FMLD	27.04	26.22	20	24	1.54	1.86	25.01	23.75	27	23	1.65	2.16
FAPD	30.54	29.88	20	24	2.76	2.45	26.55	26.29	27	23	2.18	2.24
TML	383.39	384.48	23	23	18.45	20.18	353.00	354.55	24	21	16.42	18.58
TFL	379.44	380.78	23	23	18.08	20.11	349.52	350.79	24	21	16.44	18.37
TPB	74.93	74.86	20	21	4.43	3.83	68.48	68.90	23	24	3.95	4.02
TPAB	73.13	73.34	20	21	4.37	3.97	66.59	67.20	23	24	3.94	3.83
TMLD	22.75	24.52	22	21	2.12	1.86	20.85	22.55	24	21	1.63	2.61
TAPD	30.18	29.97	22	21	1.92	2.13	27.38	26.89	24	21	2.24	1.77
FIML	373.21	369.11	12	14	20.97	20.18	339.09	343.06	17	17	17.84	18.39
BIB	283.00		21		14.82		268.20		23		12.52	
IBL	154.81	155.00	16	15	7.77	8.15	146.86	147.67	22	18	7.22	6.89
ACH	51.53	51.42	24	22	2.29	2.71	46.76	46.56	25	25	2.38	2.58
TCH	66.89	67.62	22	21	3.36	4.16	60.74	62.34	23	22	4.02	4.09
TTB	31.13	31.64	22	24	1.30	1.61	28.76	29.19	24	23	1.90	1.91

ELIZABETH / LOWER ILLINOIS RIVER MIDDLE WOODLAND

Dimension	MALES						FEMALES					
	Mean		<i>n</i>	Std. Dev.		Mean		<i>n</i>	Std. Dev.			
	left	right		left	right	left	right		left	right		
BBH	141.54		26	5.01		137.15		20	6.61			
GBL	176.86		29	6.80		170.05		19	6.81			
EUB	137.33		30	5.53		133.32		19	3.65			
UFH	83.02		29	5.10		78.95		19	4.59			
NAH	29.37		28	2.86		27.59		19	2.29			
NAW	25.12		32	2.25		24.90		19	1.84			
ZYG	136.48		25	5.52		129.68		19	5.76			
JNB	28.16		9	2.71		24.52		7	3.27			
CML	157.14	154.94	36	40	8.79	10.00	143.63	142.85	20	20	9.41	10.36
CAPD	11.71	12.27	36	40	1.30	1.59	10.24	10.77	20	20	0.91	1.25
CSID	10.04	10.21	36	40	1.41	1.48	8.70	8.87	20	20	1.10	0.93
C1	11.57		25	1.38		10.33		12	1.36			
XC2	37.25		28	2.80		35.15		11	2.21			
XC3	12.98		28	1.25		12.55		11	0.98			
XC4	12.77		27	1.10		12.07		13	0.65			
XC5	12.58		27	1.08		12.25		13	0.92			
XC6	13.02		27	1.27		12.34		14	1.07			
XC7	14.52		26	1.31		13.54		14	1.22			
XT1	16.87		27	1.14		15.52		14	0.98			
XT2	18.40		26	1.11		17.13		13	1.03			
XT3	18.56		26	0.87		18.12		14	3.85			
XT4	18.93		27	0.88		17.57		13	1.19			
XT5	19.42		27	1.10		18.26		14	1.05			
XT6	20.23		25	0.95		18.57		14	1.33			
XT7	21.10		25	1.21		19.25		14	1.09			
XT8	21.45		25	1.10		19.65		14	1.29			
XT9	21.89		25	1.18		20.25		14	1.38			
XT10	22.72		29	1.09		20.63		14	1.45			
XT11	24.77		30	8.50		21.33		13	2.01			
XT12	25.08		29	1.41		23.28		13	2.03			
XL1	26.38		30	1.72		24.80		16	2.04			
XL2	26.57		30	2.04		26.12		14	1.72			
XL3	27.59		30	1.84		26.70		14	1.84			
XL4	28.63		30	1.83		27.73		15	1.74			

ELIZABETH / LOWER ILLINOIS RIVER MIDDLE WOODLAND, CONTINUED

Dimension	MALES						FEMALES					
	Mean		n		Std. Dev.		Mean		n		Std. Dev.	
	left	right			left	right	left	right			left	right
XL5	28.63		30		1.80		27.61		16		2.76	
S1	31.42		43		2.25		30.86		22		2.09	
SML	107.55		34		9.98		108.38		17		11.59	
HML	322.46	324.23	43	45	17.56	16.41	302.38	307.10	20	20	16.70	16.26
HEB	59.29	60.27	43	43	3.58	3.47	53.75	54.70	20	20	2.67	3.18
HHD	44.45	44.85	44	45	2.57	2.75	40.39	40.17	20	21	2.79	2.42
HMLD	20.81	21.42	43	45	1.87	2.08	19.00	19.23	21	20	1.68	1.48
HAPD	20.59	21.57	43	45	1.73	1.78	19.51	19.96	21	20	1.27	1.57
HAB	42.17	42.87	43	43	2.15	2.30	38.97	39.51	20	20	1.81	1.98
RML	252.90	253.34	39	37	13.74	12.84	231.14	236.78	21	16	11.78	12.20
RMLD	14.58	14.80	39	40	1.74	1.71	13.46	13.40	21	17	1.35	1.49
RAPD	12.10	12.18	39	40	1.00	1.10	11.04	10.96	21	17	0.97	0.96
RMLH	21.96	22.00	39	37	1.26	1.31	20.26	20.24	21	19	1.10	1.22
RAPH	22.56	22.64	39	37	1.21	1.46	21.04	20.81	21	18	1.03	1.15
RAB	25.04	25.27	38	41	1.60	1.47	23.51	23.71	21	18	1.68	1.48
UML	269.21	273.49	35	35	12.55	11.10	250.58	255.75	20	14	13.56	12.47
UMLD	12.91	13.61	35	39	1.44	1.28	12.23	11.83	20	13	1.67	1.32
UAPD	15.50	15.30	35	39	1.75	1.55	14.31	14.62	20	13	1.29	1.48
FML	448.38	447.30	43	38	24.43	25.74	423.79	422.23	21	20	24.31	26.37
FBL	445.01	443.70	43	38	23.95	25.43	418.86	416.98	21	20	23.68	25.71
FEB	78.63	78.94	41	35	4.67	4.56	72.39	72.63	19	20	4.64	4.56
FAB	68.98	69.72	42	36	4.05	4.51	62.58	62.51	19	20	3.93	3.75
FHD	44.80	44.80	43	43	2.57	2.50	40.87	40.75	22	21	2.98	2.79
FMLD	26.66	26.07	44	39	2.58	2.43	25.07	23.72	21	21	2.14	1.37
FAPD	29.12	29.08	43	39	2.40	2.31	25.51	25.40	21	21	1.88	1.61
TML	380.96	379.26	37	35	20.51	21.14	355.65	352.00	20	19	19.06	18.07
TFL	376.46	374.84	37	35	20.13	20.85	351.20	347.95	20	19	18.22	17.66
TPB	74.75	73.99	38	34	3.52	3.87	67.68	66.84	19	19	3.98	3.69
TPAB	72.23	72.22	39	35	3.74	4.19	66.23	65.15	19	19	3.91	3.50
TMLD	22.88	23.94	36	34	2.20	2.34	21.57	22.55	17	19	2.44	1.78
TAPD	29.86	29.77	36	34	2.77	2.96	26.47	27.01	17	19	2.48	2.69
FIML	359.91	362.02	27	23	20.71	22.70	343.00	337.68	13	19	17.74	17.48
BIB	274.24		38		15.22		266.11		22		11.55	
IBL	154.26	153.85	31	33	8.14	6.73	146.25	148.42	16	19	7.12	7.24
ACH	50.13	50.00	42	41	2.88	2.85	46.70	46.75	22	22	3.24	3.07
TCH	68.06	67.56	8	9	2.54	3.26	61.83	61.70	6	5	4.83	6.57
TTB	30.65	30.75	11	11	1.74	1.77	27.76	28.01	6	6	2.05	2.25

KUHLMAN

Dimension	MALES						FEMALES					
	Mean		n	Std. Dev.		Mean		n	Std. Dev.			
	left	right		left	right	left	right		left	right		
BBH	141.43		7	4.31		134.00		6	4.56			
GBL	179.00		7	4.58		172.67		6	1.97			
EUB	134.14		7	1.68		132.33		6	1.97			
UFH	83.98		7	2.52		79.81		6	4.12			
NAH	26.55		8	1.88		26.01		6	2.88			
NAW	24.89		8	1.16		23.89		6	2.30			
ZYG	132.86		7	5.05		128.33		6	3.93			
JNB	25.28		5	3.24		23.80		5	3.03			
CML	153.17	151.57	6	7	12.35	10.77	138.33	135.83	6	6	4.58	6.28
CAPD	12.01	11.70	6	7	1.35	1.15	9.65	10.45	6	6	0.70	1.17
CSID	9.77	9.81	6	7	0.77	0.63	7.88	8.51	6	6	0.74	1.09
C1	12.09		7	1.62		10.07		5	1.78			
XC2	37.29		6	2.45		33.63		5	2.61			
XC3	13.75		6	0.87		11.60		5	0.75			
XC4	13.26		6	0.61		11.13		5	1.37			
XC5	13.11		6	0.76		11.22		5	0.74			
XC6	12.87		6	0.51		12.10		6	0.58			
XC7	14.03		6	1.14		13.19		6	0.83			
XT1	17.25		6	0.72		15.38		6	0.63			
XT2	17.95		6	0.77		16.78		6	0.86			
XT3	17.64		6	0.73		16.47		6	0.58			
XT4	18.32		6	0.83		17.02		5	0.58			
XT5	18.94		7	0.71		17.34		5	0.52			
XT6	19.69		5	0.56		18.03		4	0.98			
XT7	20.22		5	1.24		18.68		4	0.69			
XT8	20.92		6	1.04		19.25		4	0.69			
XT9	21.90		6	1.20		19.69		4	0.83			
XT10	22.16		6	0.92		20.47		4	0.74			
XT11	22.74		7	1.39		20.82		4	0.38			
XT12	24.49		7	1.09		23.18		4	0.90			
XL1	26.20		7	0.99		24.21		5	1.00			
XL2	26.31		7	1.27		25.11		5	1.02			
XL3	27.16		8	1.19		25.89		5	1.08			
XL4	28.04		8	0.93		26.93		5	1.52			

KUHLMAN, CONTINUED

Dimension	MALES						FEMALES					
	Mean		n	Std. Dev.		Mean		n	Std. Dev.			
	left	right		left	right	left	right		left	right		
XL5	28.17		8	1.20		27.85		5	1.57			
S1	30.16		8	2.14		28.83		4	3.24			
SML	105.23		5	9.87		121.89		2	7.66			
HML	315.79	319.86	7	7	10.41	11.28	303.92	307.83	6	6	9.36	9.34
HEB	59.86	60.43	7	7	2.63	2.86	54.25	52.67	6	6	4.12	1.97
HHD	44.17	43.37	7	7	1.21	1.81	39.46	39.92	6	6	2.70	2.59
HMLD	20.45	21.12	7	7	1.22	0.90	18.43	19.08	6	6	2.43	2.01
HAPD	20.60	21.57	7	7	1.90	1.31	20.01	20.22	6	6	1.38	2.01
HAB	41.33	41.83	7	7	2.09	3.01	39.22	38.92	5	6	2.07	2.58
RML	245.81	248.57	8	7	9.63	8.81	229.30	235.63	5	4	5.67	5.63
RMLD	14.39	14.83	8	7	0.70	1.51	13.86	12.85	5	4	1.54	1.33
RAPD	11.71	11.41	8	7	0.70	0.53	10.68	10.31	5	4	0.84	0.73
RMLH	21.03	21.62	8	7	0.66	0.90	19.48	20.52	6	5	1.20	0.68
RAPH	22.10	22.46	8	7	0.63	1.07	20.37	20.98	6	5	0.90	0.72
RAB	24.78	25.12	8	7	0.96	1.93	24.32	23.81	5	5	1.16	1.44
UML	265.07	266.00	7	8	7.73	8.29	248.20	251.40	5	5	3.65	4.51
UMLD	12.59	13.01	7	8	1.39	0.62	11.31	11.69	5	5	0.99	0.73
UAPD	15.55	15.38	7	8	1.53	1.64	13.91	14.36	5	5	1.21	1.62
FML	445.50	438.69	6	8	14.74	13.16	424.58	422.42	6	6	17.46	19.50
FBL	438.90	435.88	5	8	14.96	13.13	418.50	418.25	6	6	19.86	19.18
FEB	77.50	76.50	6	5	3.10	1.22	69.67	71.38	6	4	5.69	5.36
FAB	68.49	67.76	6	6	3.01	2.62	61.28	62.02	6	4	5.44	5.00
FHD	44.50	43.92	6	8	1.21	1.68	40.89	40.94	6	6	2.88	3.10
FMLD	25.61	25.70	6	8	1.65	1.34	23.64	23.12	6	6	1.73	1.56
FAPD	31.02	29.20	6	8	1.72	3.10	25.86	24.74	6	6	1.80	1.59
TML	374.38	369.90	8	5	14.57	8.39	354.08	351.00	6	5	6.43	5.49
TFL	369.75	365.30	8	5	14.07	7.00	350.19	347.50	6	5	5.85	5.77
TPB	72.13	72.83	8	6	3.64	2.79	66.20	66.13	5	4	4.60	4.44
TPAB	70.04	70.94	8	6	3.36	2.66	64.40	64.72	5	4	5.11	4.50
TMLD	21.33	23.63	8	5	1.12	2.34	19.95	21.11	6	5	1.00	1.27
TAPD	28.98	27.59	8	5	1.98	2.51	25.48	25.32	6	5	2.02	2.51
FIML	355.25	352.88	6	4	9.76	10.17	342.67	339.38	3	4	5.51	12.39
BIB	270.25		4		8.87		256.17		3		10.07	
IBL	154.00	156.00	4	3	5.42	3.61	147.00	148.40	3	5	6.08	4.28
ACH	50.69	49.43	7	6	1.32	2.30	44.70	46.01	4	6	3.66	3.29
TCH	64.75	65.57	6	7	2.75	2.75	59.25	60.50	4	5	2.99	3.98
TTB	29.78	29.75	6	7	1.66	1.33	27.92	28.14	5	5	2.45	1.98

MODOC ROCK SHELTER

Dimension	MALES					FEMALES						
	Mean		n	Std. Dev.		Mean		n	Std. Dev.			
	left	right		left	right	left	right		left	right		
BBH	140.60		5	5.59		135.33		6	4.50			
GBL	182.50		4	3.87		176.00		7	7.00			
EUB	140.33		3	4.93		138.00		7	5.23			
UFH	78.61		4	7.89		75.00		3	2.45			
NAH	28.77		5	2.25		31.10		3	4.36			
NAW	25.38		5	1.86		22.51		4	1.30			
ZYG	141.50		4	6.95		133.50		4	4.20			
JNB	25.18		6	2.83		25.75		5	1.03			
CML	156.00	154.30	5	5	7.31	5.74	135.86	137.00	7	4	13.97	14.58
CAPD	12.05	11.56	5	5	1.68	1.50	9.71	10.85	7	4	1.08	1.56
CSID	10.14	10.70	5	5	0.98	0.93	8.87	8.56	7	4	1.30	1.24
C1	11.22		6	1.56		10.28		3	0.58			
XC2	37.28		6	2.01		32.97		5	3.12			
XC3	12.80		6	0.90		11.12		5	0.99			
XC4	12.73		6	0.68		11.28		5	0.56			
XC5	12.09		6	1.28		10.86		6	0.92			
XC6	12.60		6	1.15		11.62		8	1.31			
XC7	13.70		6	1.77		13.25		8	1.53			
XT1	15.77		6	1.75		14.78		7	1.01			
XT2	16.92		6	2.27		16.74		7	0.95			
XT3	17.73		6	1.72		17.10		7	0.82			
XT4	18.49		6	1.39		17.46		7	1.29			
XT5	19.01		6	1.13		18.18		7	1.09			
XT6	19.82		6	1.23		18.85		6	0.72			
XT7	20.10		6	1.14		19.31		7	1.00			
XT8	20.75		6	0.78		19.70		6	0.81			
XT9	21.75		6	1.03		20.51		5	0.80			
XT10	21.98		6	1.30		21.16		5	1.02			
XT11	22.19		5	1.34		21.74		6	0.73			
XT12	24.85		5	1.05		23.18		6	1.30			
XL1	25.90		6	1.22		24.46		6	0.37			
XL2	25.76		6	1.12		25.26		5	0.43			
XL3	27.00		7	2.34		25.24		6	1.73			
XL4	27.74		7	2.17		25.80		6	1.14			

MODOC ROCK SHELTER, CONTINUED

Dimension	MALES						FEMALES					
	Mean		n	Std. Dev.		Mean		n	Std. Dev.			
	left	right		left	right	left	right		left	right		
XL5	27.80		7	1.16		26.12		6	1.98			
S1	31.61		5	1.96		27.93		6	1.68			
SML	105.49		2	6.99		112.51		2	12.16			
HML	322.50	325.50	6	3	25.88	22.46	303.42	309.10	6	5	18.18	19.98
HEB	58.83	59.63	6	4	2.84	2.06	55.64	56.00	7	6	4.38	4.79
HHD	45.96	46.37	6	4	3.13	2.01	41.39	41.24	6	6	2.90	2.92
HMLD	19.44	20.60	6	3	1.72	0.86	16.87	19.49	5	5	2.15	3.10
HAPD	19.31	20.09	6	3	1.42	1.10	17.47	18.06	5	5	2.60	2.51
HAB	42.63	41.95	6	4	3.36	1.84	38.29	39.30	7	6	3.13	3.38
RML	251.21	259.25	7	4	17.15	15.85	230.71	234.08	7	6	19.24	22.16
RMLD	14.06	13.92	7	4	1.21	1.09	12.49	13.05	8	6	1.86	1.49
RAPD	11.78	12.08	7	4	1.16	1.14	10.27	10.31	8	6	1.19	1.16
RMLH	21.74	22.17	7	6	1.28	1.67	20.03	20.20	7	6	1.74	2.22
RAPH	22.64	22.89	7	6	1.48	1.67	20.74	21.41	8	6	1.85	2.66
RAB	25.08	25.07	5	5	1.35	1.40	22.77	22.64	8	7	1.23	1.24
UML	273.58	276.75	6	4	22.89	17.84	247.75	256.40	6	5	16.73	24.38
UMLD	12.36	12.85	6	4	1.12	0.25	11.37	12.72	6	5	1.08	1.42
UAPD	14.73	14.78	6	4	1.24	1.50	13.39	13.68	6	5	1.60	1.11
FML	453.75	457.75	6	4	31.29	35.30	415.40	417.00	5	6	13.90	21.20
FBL	449.83	453.63	6	4	31.58	35.49	411.60	412.58	5	6	12.86	21.48
FEB	78.38	79.00	4	4	3.20	3.74	72.88	72.00	4	6	3.47	3.94
FAB	69.28	69.30	4	4	5.25	4.16	64.90	63.44	4	6	5.01	3.78
FHD	45.52	45.92	6	4	3.38	3.20	40.66	41.10	7	8	2.96	3.63
FMLD	25.37	26.54	6	4	1.86	1.49	23.45	23.87	5	6	.86	1.91
FAPD	28.42	28.29	6	4	3.82	4.70	24.96	25.05	5	6	2.74	2.99
TML	396.80	390.25	5	6	32.36	32.08	358.10	351.83	5	6	27.74	24.51
TFL	392.90	386.33	5	6	32.42	31.12	352.45	348.79	5	6	25.78	24.46
TPB	73.25	75.40	4	5	3.59	3.21	69.33	67.83	3	3	5.11	5.35
TPAB	69.97	73.95	4	5	3.41	2.92	68.26	66.20	3	3	5.08	5.46
TMLD	22.79	22.40	5	6	2.08	3.35	19.09	20.36	5	6	2.56	1.60
TAPD	29.50	28.92	5	6	2.16	2.49	26.95	24.71	5	6	1.32	1.69
FIML	356.75	393.67	4	3	21.74	13.51	327.33	355.83	3	3	26.58	13.04
BIB	273.67		3	21.08		260.00		2	5.66			
IBL	158.50	165.00	2	2	13.44	4.24	146.00	153.00	3	1	8.19	
ACH	52.52	50.44	3	2	1.68	3.36	47.81	47.35	3	5	4.65	4.04
TCH	66.50	68.30	4	5	4.20	5.02	57.13	57.92	4	6	4.09	5.17
TTB	30.88	31.54	7	5	2.78	3.08	27.06	27.30	6	7	1.89	2.16

INDIAN KNOLL

Dimension	MALES						FEMALES					
	Mean		n	Std. Dev.		Mean		n	Std. Dev.			
	left	right		left	right	left	right		left	right		
BBH	138.04		27	5.03		132.20		30	5.28			
GBL	176.82		27	6.49		170.03		29	4.65			
EUB	135.44		27	4.39		130.29		28	4.05			
UFH	78.13		28	3.98		74.36		29	4.28			
NAH	28.34		24	2.62		26.02		26	2.23			
NAW	23.46		28	1.63		22.97		29	1.73			
ZYG	134.96		28	4.27		126.53		30	5.24			
JNB	23.72		27	3.24		22.58		25	2.07			
CML	147.12	144.13	29	28	10.28	9.45	131.92	131.13	25	28	5.11	6.53
CAPD	10.62	11.95	29	28	1.20	.84	9.18	9.65	25	28	0.70	0.88
CSID	9.02	9.41	29	28	1.01	1.06	7.94	8.17	25	28	0.81	0.85
C1	10.83		30	0.80		9.69		24	0.84			
XC2	34.40		30	2.08		32.29		28	1.77			
XC3	11.93		30	0.83		11.12		28	1.02			
XC4	11.79		30	0.72		10.91		28	0.95			
XC5	11.58		30	0.82		10.44		28	1.09			
XC6	11.91		30	0.63		10.95		28	0.82			
XC7	13.49		30	0.69		12.46		28	0.83			
XT1	15.50		30	1.00		14.35		28	1.00			
XT2	17.00		30	0.83		15.86		28	1.01			
XT3	17.36		30	0.86		16.17		27	0.82			
XT4	17.85		30	1.00		16.78		27	0.94			
XT5	18.67		30	1.11		17.43		27	0.87			
XT6	19.45		30	0.93		18.19		27	0.89			
XT7	20.11		30	0.79		18.72		27	0.86			
XT8	20.56		30	0.73		19.24		27	0.88			
XT9	21.11		30	0.90		19.60		28	0.67			
XT10	21.38		30	0.98		20.05		28	0.87			
XT11	22.05		28	0.85		20.93		29	1.06			
XT12	23.81		26	1.06		22.80		28	1.33			
XL1	24.52		27	1.17		24.28		29	1.08			
XL2	24.94		27	1.06		24.72		28	1.11			
XL3	26.18		26	1.30		25.68		27	1.41			
XL4	26.94		26	1.41		26.36		26	1.26			

INDIAN KNOLL, CONTINUED

Dimension	MALES						FEMALES					
	Mean		<i>n</i>		Std. Dev.		Mean		<i>n</i>		Std. Dev.	
	left	right			left	right	left	right			left	right
XL5	27.15		27		2.01		26.47		27		1.77	
S1	29.49		31		1.87		28.78		29		2.54	
SML	107.33		25		9.55		105.40		23		6.43	
HML	318.17	320.90	30	30	16.26	16.58	294.14	294.84	29	28	11.61	9.86
HEB	55.53	56.98	31	30	2.80	2.97	49.83	50.59	29	28	2.46	2.33
HHD	43.04	43.61	30	30	2.63	2.62	38.24	37.85	29	28	2.12	2.20
HMLD	19.01	20.70	31	30	1.50	1.23	16.59	17.09	29	29	1.31	1.44
HAPD	17.54	19.57	31	30	1.29	1.39	15.33	16.81	29	29	1.05	1.09
HAB	39.01	39.83	31	30	1.88	1.68	34.60	34.78	29	29	1.47	1.41
RML	244.82	247.15	28	27	11.16	11.50	218.68	223.36	25	28	11.36	9.96
RMLD	13.05	13.63	28	29	1.26	1.16	11.45	11.80	25	29	1.25	1.33
RAPD	11.05	11.53	28	29	0.97	0.92	9.65	9.70	25	29	0.89	0.93
RMLH	20.45	20.77	30	29	1.21	1.11	18.02	18.05	29	29	1.02	1.15
RAPH	21.45	21.60	29	27	1.35	1.23	18.73	18.54	29	29	1.19	1.14
RAB	23.60	23.89	29	30	1.37	1.55	21.45	21.78	26	29	1.17	1.27
UML	262.50	263.98	28	27	12.39	12.06	237.44	240.02	26	24	11.12	9.26
UMLD	11.54	12.69	29	28	0.79	0.90	10.05	11.02	26	26	0.65	1.19
UAPD	12.47	12.96	29	28	1.36	1.23	11.64	12.07	26	26	1.27	.99
FML	439.60	435.83	31	29	21.47	22.11	406.15	404.14	30	28	18.24	19.40
FBL	436.34	432.64	31	29	21.43	21.92	401.08	399.41	30	29	18.10	19.17
FEB	76.19	76.39	31	28	3.47	3.84	68.17	68.44	29	25	3.51	3.20
FAB	66.73	67.10	31	28	2.84	3.12	59.60	59.61	30	27	3.12	3.18
FHD	42.66	42.79	31	30	2.11	2.17	38.27	38.29	30	29	1.95	1.83
FMLD	23.73	23.67	31	29	1.73	1.64	22.02	22.05	30	28	1.53	1.44
FAPD	26.76	26.75	31	29	1.76	1.89	23.56	23.65	30	28	1.76	1.69
TML	367.79	365.45	31	28	17.47	17.00	336.96	335.43	28	28	16.70	15.84
TFL	362.68	360.86	31	28	17.46	17.25	332.69	331.36	28	28	16.53	15.79
TPB	70.57	70.48	28	28	3.09	3.43	63.46	63.74	26	27	2.95	2.57
TPAB	69.06	69.03	28	28	2.77	3.54	62.00	62.13	26	27	2.79	2.48
TMLD	20.49	21.70	31	28	1.36	1.69	18.19	19.13	28	28	1.19	1.38
TAPD	27.20	26.91	31	28	1.55	2.00	22.76	22.67	28	28	1.52	1.69
FIML	350.84	351.74	25	21	16.85	15.35	318.76	319.27	19	22	12.45	14.53
BIB	258.68		30		10.80		249.85		29		11.67	
IBL	148.96	148.85	28	27	7.21	8.42	139.36	139.68	28	25	6.95	7.12
ACH	47.58	47.74	30	31	2.33	2.52	43.44	42.86	30	30	2.30	2.15
TCH	62.44	64.18	27	28	3.65	3.51	55.55	57.58	22	26	2.95	3.06
TTB	28.45	28.38	29	29	1.39	1.22	25.42	25.48	24	27	1.52	1.52

WARD PLACE AND LOUSIANA SITES

Dimension	MALES						FEMALES					
	Mean		n	Std. Dev.		Mean		n	Std. Dev.			
	left	right		left	right	left	right		left	right		
BBH	143.50		8	6.16		135.27		11	6.50			
GBL	166.75		8	7.70		164.33		12	8.56			
EUB	146.25		8	4.95		143.50		12	5.21			
UFH	84.74		5	4.96		77.84		11	5.88			
NAH	27.27		5	1.77		27.81		11	2.78			
NAW	26.39		6	2.13		25.49		11	1.77			
ZYG	147.67		6	5.13		135.91		11	5.41			
JNB	25.95		2	3.60		24.07		5	1.29			
CML	152.75	149.93	6	7	6.75	6.11	142.44	141.63	9	8	11.03	11.35
CAPD	12.55	12.32	6	7	1.29	1.12	10.43	10.81	9	8	1.24	1.64
CSID	10.47	9.82	6	7	2.26	1.15	9.32	9.26	9	8	1.56	1.59
C1	10.79		7	1.15		10.10		8	1.30			
XC2	37.14		7	2.11		36.42		6	2.01			
XC3	12.80		7	1.07		11.35		5	0.90			
XC4	13.06		7	0.61		11.31		6	0.76			
XC5	12.47		6	0.97		11.21		5	0.82			
XC6	12.98		7	0.88		12.03		7	0.89			
XC7	14.44		7	0.70		13.25		7	1.03			
XT1	16.55		8	1.09		15.15		6	0.69			
XT2	18.77		9	0.96		16.81		10	1.02			
XT3	18.43		9	1.12		17.32		9	0.86			
XT4	18.80		10	0.70		17.72		8	0.86			
XT5	19.84		10	0.80		18.35		8	0.93			
XT6	20.38		10	1.02		18.62		9	1.21			
XT7	20.52		9	0.76		19.15		9	1.07			
XT8	21.07		9	1.00		19.47		8	0.93			
XT9	21.51		9	0.94		20.05		9	0.84			
XT10	22.23		9	1.11		20.84		9	1.04			
XT11	23.41		10	1.40		21.86		10	1.05			
XT12	24.67		10	1.51		23.48		10	1.49			
XL1	25.63		10	1.35		24.90		10	2.10			
XL2	25.84		10	1.69		25.70		9	1.94			
XL3	27.12		10	1.87		26.96		9	1.58			
XL4	27.77		9	1.90		27.00		9	1.77			

WARD PLACE AND LOUISIANA SITES, CONTINUED

Dimension	MALES						FEMALES					
	Mean		<i>n</i>		Std. Dev.		Mean		<i>n</i>		Std. Dev.	
	left	right			left	right	left	right			left	right
XL5	28.67		9		1.40		27.30		9		2.28	
S1	31.13		10		2.04		29.81		9		1.32	
SML	111.21		7		9.14		104.12		9		7.41	
HML	322.50	322.28	8	9	8.29	8.72	303.60	307.56	10	9	14.27	13.53
HEB	60.25	60.72	8	9	3.44	3.50	53.45	55.56	10	9	3.86	3.75
HHD	46.18	46.37	8	9	1.88	2.88	39.68	40.39	10	9	2.62	2.75
HMLD	22.36	22.85	8	9	2.06	1.69	19.79	19.51	10	9	1.67	1.80
HAPD	20.83	21.69	8	9	1.12	1.41	19.20	20.20	10	9	1.53	1.62
HAB	42.76	43.29	8	9	1.85	2.38	38.36	38.92	10	9	2.62	2.77
RML	250.44	254.30	9	10	12.13	9.42	229.78	234.45	9	10	13.42	12.38
RMLD	15.31	15.34	9	10	1.63	1.55	13.48	14.16	9	11	1.48	1.39
RAPD	12.39	12.66	9	10	1.03	1.04	11.36	11.31	9	11	1.19	1.16
RMLH	21.46	21.74	9	10	1.38	1.25	18.90	19.78	7	9	1.73	1.11
RAPH	22.11	23.00	9	9	1.58	1.42	20.09	20.74	8	9	1.22	1.73
RAB	26.15	27.02	9	9	1.60	1.57	23.92	24.38	8	10	1.29	1.37
UML	266.00	275.07	8	7	11.20	6.85	248.61	248.72	9	9	13.71	14.05
UMLD	13.27	14.59	9	7	1.06	1.05	11.83	12.37	11	9	1.26	0.94
UAPD	15.90	15.45	9	7	1.41	1.16	14.03	13.59	11	9	1.28	1.07
FML	451.46	444.94	11	9	18.29	10.79	426.06	426.33	9	9	21.27	21.47
FBL	447.77	442.81	11	8	18.91	11.00	421.67	418.44	9	8	21.59	20.00
FEB	79.22	80.11	9	9	1.48	2.33	72.56	72.86	8	7	2.54	2.48
FAB	68.35	69.03	9	9	1.30	2.20	62.28	62.28	9	7	2.32	2.57
FHD	46.54	45.93	11	9	1.68	2.16	40.37	41.10	8	9	1.99	2.81
FMLD	27.40	26.27	11	9	1.57	1.44	25.43	24.43	8	9	1.29	1.11
FAPD	29.69	29.81	11	9	1.40	2.32	26.35	26.30	8	9	2.59	1.92
TML	376.00	373.00	9	9	16.15	16.17	357.00	361.75	8	6	18.66	16.42
TFL	372.22	369.28	9	9	16.66	16.71	352.50	358.57	8	6	19.60	16.65
TPB	74.29	74.05	7	10	1.70	2.75	67.75	68.10	6	5	3.37	3.97
TPAB	69.80	70.44	7	10	1.40	1.32	64.59	64.96	6	5	2.96	3.99
TMLD	22.31	24.30	9	9	1.44	2.12	20.66	23.47	8	6	1.06	1.47
TAPD	29.57	29.65	9	9	2.12	2.40	27.27	27.23	8	6	2.10	1.83
FIML	368.83	367.00	3	4	19.21	18.04	340.00	343.17	1	3		2.47
BIB	273.69		8		18.61		266.69		8		9.92	
IBL	155.00	154.67	3	3	6.08	6.43	147.43	147.60	7	5	3.60	2.61
ACH	52.01	51.75	7	7	1.45	1.78	44.89	46.00	6	6	0.44	3.20
TCH	65.79	65.69	7	8	3.96	2.96	60.50	61.58	5	6	3.50	2.25
TTB	29.12	29.61	6	8	1.07	1.22	27.07	26.92	6	7	1.10	1.23

MAINE SITES

Dimension	MALES						FEMALES					
	Mean		n	Std. Dev.		Mean		n	Std. Dev.			
	left	right		left	right	left	right		left	right		
BBH	135.57		7	6.50		132.60		5	3.97			
GBL	188.29		7	11.79		182.20		5	10.69			
EUB	138.29		7	6.26		137.20		5	2.59			
UFH	81.86		5	6.05		81.48		3	4.21			
NAH	25.55		4	1.77		27.41		3	1.32			
NAW	22.56		5	2.02		24.14		3	0.79			
ZYG	134.20		5	9.98		133.00		4	3.74			
JNB	24.84		1			23.37		1				
CML	147.75	142.50	4	4	10.51	8.82	133.00	132.50	1	2	0.71	
CAPD	11.40	11.05	4	4	2.15	1.85	9.57	9.47	1	2	0.23	
CSID	10.06	10.54	4	4	1.21	1.18	8.92	9.00	1	2	0.27	
C1	12.83		4	1.02		10.14		2	1.78			
XC2	35.98		5	3.17		35.61		2	2.84			
XC3	12.41		5	1.10		10.88		2	0.66			
XC4	12.85		3	0.46		10.14		2	0.52			
XC5	11.96		5	0.94		10.79		2	0.23			
XC6	12.60		5	1.76		10.69		2	1.00			
XC7	13.75		5	1.63		12.51		2	1.23			
XT1	16.48		6	0.80		14.76		2	0.20			
XT2	17.60		6	1.03		15.57		2	0.95			
XT3	17.64		6	1.11		16.45		2	0.18			
XT4	18.28		5	1.52		17.80		1				
XT5	18.88		5	1.61		17.69		1				
XT6	19.52		5	1.59		18.07		2	0.06			
XT7	20.81		4	2.01		18.43		2	0.12			
XT8	21.22		4	1.84		19.07		2	0.11			
XT9	21.10		5	1.45		19.30		2	0.54			
XT10	21.91		6	0.96		19.76		2	0.74			
XT11	23.34		5	1.80		20.13		2	0.27			
XT12	24.37		5	2.06		22.09		2	1.00			
XL1	25.67		6	1.60		23.74		2	1.83			
XL2	26.12		6	1.50		24.01		2	1.05			
XL3	26.53		6	0.83		23.85		2	0.90			
XL4	27.32		6	1.47		24.69		2	0.31			

MAINE SITES, CONTINUED

Dimension	MALES						FEMALES					
	Mean		n	Std. Dev.		Mean		n	Std. Dev.			
	left	right		left	right	left	right		left	right		
XL5	27.14		6	1.28		24.73		2	0.88			
S1	30.93		4	1.67		29.16		2	0.63			
SML	108.56		3	5.55		115.61		2	0.93			
HML	321.13	327.67	4	3	19.61	20.53	303.50	301.00	1	2		0.00
HEB	60.70	60.00	5	5	4.48	3.72	51.00	54.50	1	2		2.83
HHD	44.74	44.54	3	4	1.55	3.01	40.96	39.84	2	2	4.04	2.86
HMLD	22.13	21.13	4	3	2.68	3.08	18.62	20.36	1	2		0.75
HAPD	21.54	20.50	4	3	2.25	2.98	17.46	19.42	1	2		0.85
HAB	41.36	42.94	5	5	2.79	4.26	36.79	38.03	1	2		0.89
RML	245.83	238.00	6	1	15.51		234.50	234.25	2	2	11.31	8.84
RMLD	14.74	17.29	6	1	2.07		13.27	13.59	2	2	0.65	0.68
RAPD	11.93	13.59	6	1	0.93		9.85	10.45	2	2	1.43	0.56
RMLH	20.82	22.26	6	4	1.07	1.40	17.65	19.57	2	2	0.32	1.39
RAPH	21.42	22.45	6	4	1.77	1.88	19.00	20.62	2	2	1.72	1.80
RAB	25.13	26.29	5	3	1.95	2.61	21.90	23.20	2	2	1.29	2.78
UML	270.25	247.00	2	1	20.15			258.50		2		7.78
UMLD	12.90	10.09	2	1	1.07			11.24		2		0.86
UAPD	14.52	13.42	2	1	1.13			13.68		2		0.44
FML	445.33	443.17	6	6	27.51	26.30	416.50	412.50	2	2	20.51	23.33
FBL	442.67	440.92	6	6	27.69	26.50	412.75	410.00	2	2	19.45	21.21
FEB	78.90	78.75	5	4	3.52	4.99	71.50	72.25	2	2	2.12	2.47
FAB	68.42	69.17	6	4	6.08	5.58	62.86	63.86	2	2	2.82	1.29
FHD	44.07	44.27	6	6	2.20	2.43	40.62	41.23	2	2	2.35	3.85
FMLD	25.95	25.89	6	6	3.08	2.52	23.88	23.92	2	2	0.64	1.05
FAPD	27.67	28.42	6	6	2.75	3.08	24.73	24.76	2	2	0.04	0.24
TML	365.80	368.50	5	4	18.99	18.12	349.75	367.00	2	1	23.69	
TFL	363.00	363.88	5	4	19.70	18.96	345.00	362.00	2	1	21.21	
TPB	73.20	74.00	5	3	2.93	6.56	68.50	68.50	2	2	0.71	3.54
TPAB	70.83	73.22	5	3	2.77	6.67	66.99	67.53	2	2	1.27	3.82
TMLD	21.64	22.15	5	4	2.81	1.67	17.80	20.73	2	1	0.24	
TAPD	27.03	26.63	5	4	2.89	2.30	22.97	24.23	2	1	0.13	
FIML	350.50	345.00	2	1	25.46			344.50		1		
BIB	263.13		4		13.19		257.50		2		4.95	
IBL	158.33	160.50	3	2	3.21	6.36	150.00	141.00	1	1		
ACH	50.09	49.13	2	3	2.29	3.68	45.60	46.47	2	2	2.72	1.87
TCH	63.50	65.00	5	4	3.02	3.65	59.75	60.50	2	1	1.77	
TTB	29.62	29.51	5	4	1.78	1.46	27.32	27.70	2	1	0.23	

CAPE COD BAY

Dimension	MALES						FEMALES					
	Mean		<i>n</i>	Std. Dev.		Mean		<i>n</i>	Std. Dev.			
	left	right		left	right	left	right		left	right		
BBH	137.60		10	8.59		134.56		9	3.43			
GBL	183.80		10	7.21		177.44		9	7.16			
EUB	136.70		10	3.06		134.11		9	6.37			
UFH	83.83		9	5.02		77.04		9	6.55			
NAH	29.62		9	2.10		25.76		9	1.62			
NAW	25.53		9	1.24		24.19		9	1.30			
ZYG	142.10		10	5.34		132.56		9	4.82			
JNB	25.81		6	1.97		21.01		2	3.56			
CML	155.69	153.56	8	8	9.55	11.89	136.38	135.25	8	8	9.90	6.73
CAPD	11.78	12.17	8	8	1.35	1.54	9.41	9.97	8	8	0.77	0.71
CSID	10.30	10.02	8	8	1.19	1.41	7.62	8.59	8	8	0.96	0.55
C1	11.15		8	1.23		10.92		9	0.66			
XC2	37.72		9	2.63		34.66		9	2.20			
XC3	12.93		9	0.90		11.97		8	0.72			
XC4	12.95		8	1.26		11.71		6	1.03			
XC5	13.01		8	1.13		11.45		7	0.98			
XC6	12.60		10	0.94		11.68		8	0.78			
XC7	14.14		11	0.87		12.65		9	0.91			
XT1	16.17		9	0.94		14.26		8	0.72			
XT2	17.91		10	1.25		16.06		7	0.83			
XT3	17.83		9	1.31		16.05		7	0.72			
XT4	17.91		9	1.48		16.31		7	0.70			
XT5	18.85		8	1.03		17.13		8	0.83			
XT6	19.62		10	1.12		18.06		7	1.07			
XT7	19.87		10	1.44		18.80		8	1.27			
XT8	20.76		9	1.30		18.94		8	1.26			
XT9	21.14		9	1.54		19.40		8	1.17			
XT10	21.71		12	1.09		20.05		7	1.60			
XT11	22.07		10	1.36		20.88		10	1.22			
XT12	24.20		10	1.24		22.69		11	1.24			
XL1	26.22		10	1.42		24.21		12	0.92			
XL2	26.71		10	1.74		25.12		10	1.30			
XL3	26.55		10	1.48		25.70		10	1.31			
XL4	27.75		10	1.47		26.36		10	1.20			

CAPE COD BAY, CONTINUED

Dimension	MALES						FEMALES					
	Mean		<i>n</i>		Std. Dev.		Mean		<i>n</i>		Std. Dev.	
	left	right			left	right	left	right			left	right
XL5	28.07		10		2.50		26.44		11		1.02	
S1	31.07		10		2.85		30.27		13		1.78	
SML	113.69		6		8.98		103.71		6		3.25	
HML	324.50	326.55	12	10	17.46	20.46	303.96	307.63	11	12	10.13	11.88
HEB	58.50	59.59	11	11	3.50	3.11	50.92	52.35	6	10	4.14	3.27
HHD	44.17	44.30	12	11	2.73	2.78	39.40	39.64	12	11	2.30	1.96
HMLD	22.24	23.00	12	10	2.24	3.03	18.27	18.87	11	12	1.66	1.84
HAPD	21.41	22.38	12	10	2.35	2.61	18.31	18.97	11	12	2.00	1.23
HAB	40.43	41.66	11	12	2.85	2.70	35.56	36.79	6	12	2.52	2.91
RML	255.67	259.50	9	8	19.45	20.87	233.94	237.90	8	10	15.25	11.02
RMLD	14.13	14.70	9	8	1.71	1.60	12.80	13.74	8	10	1.71	1.66
RAPD	12.12	12.35	9	8	1.37	1.22	10.44	10.45	8	10	0.35	0.54
RMLH	21.00	21.35	8	8	1.70	1.69	18.54	19.25	9	9	1.23	1.67
RAPH	21.52	21.87	9	8	1.33	1.72	19.35	19.21	8	9	1.55	1.63
RAB	24.94	25.53	10	9	1.42	1.71	22.63	22.94	7	9	1.34	1.53
UML	277.94	277.21	8	7	19.28	20.83	250.29	258.94	7	8	12.89	7.76
UMLD	13.07	13.82	8	7	1.55	1.60	11.44	11.34	7	8	1.19	1.01
UAPD	15.81	16.90	8	7	2.19	2.30	12.28	13.79	7	8	1.06	1.63
FML	458.13	457.10	12	10	26.69	27.43	432.00	434.83	11	12	18.37	14.84
FBL	454.79	452.50	12	10	26.65	26.23	427.68	431.67	11	12	17.85	14.78
FEB	77.86	78.43	11	7	5.01	3.72	70.29	71.14	7	7	3.87	3.04
FAB	68.06	68.47	11	8	4.42	3.39	59.75	59.56	10	9	3.95	2.66
FHD	44.70	44.50	11	11	2.54	2.21	41.23	41.28	12	13	1.97	2.16
FMLD	26.19	25.78	12	10	2.41	2.04	25.00	24.03	11	12	1.75	1.48
FAPD	29.92	29.57	12	10	2.28	2.65	25.95	25.85	11	12	2.10	2.12
TML	383.18	391.50	11	9	24.56	17.81	354.72	362.55	9	11	11.01	13.52
TFL	379.59	387.28	11	9	24.54	18.93	351.72	358.96	9	11	10.81	14.02
TPB	73.10	73.63	10	8	3.45	2.43	64.50	66.06	6	8	4.00	3.81
TPAB	71.09	72.11	10	8	4.11	2.04	62.39	64.13	6	8	4.81	3.59
TMLD	22.09	23.03	11	9	2.24	2.38	20.04	21.12	9	11	1.51	1.21
TAPD	30.07	29.83	11	9	1.97	1.84	24.05	24.56	9	11	1.05	1.56
FIML	379.50	378.60	4	5	20.35	31.78	339.00	346.38	2	4	15.56	9.96
BIB	263.67		9		8.47		258.05		10		14.13	
IBL	153.60	153.17	5	6	6.99	9.15	147.67	148.57	6	7	7.45	4.72
ACH	49.32	49.32	11	11	3.27	2.62	46.69	45.82	12	12	2.38	2.25
TCH	65.50	67.83	7	6	4.44	4.84	56.64	60.63	7	8	2.87	3.55
TTB	29.37	29.56	7	8	1.80	1.94	25.78	26.62	8	9	1.43	1.30

WINNEMUCCA LAKE

Dimension	MALES					FEMALES						
	Mean		n	Std. Dev.		Mean		n	Std. Dev.			
	left	right		left	right	left	right		left	right		
BBH	130.25		4	6.55		133.33		3	6.51			
GBL	179.75		4	7.89		180.00		3	5.57			
EUB	137.75		4	6.70		136.00		3	2.00			
UFH	77.29		4	7.23		77.64		3	0.53			
NAH	28.35		4	2.21		27.07		3	2.40			
NAW	23.77		4	2.28		23.60		3	0.95			
ZYG	128.00		4	12.73		130.00		3	1.73			
JNB	25.72		1			32.33		2	0.05			
CML	150.00	144.00	2	1	7.07		135.50	131.00	2	2	2.12	7.07
CAPD	11.35	11.35	2	1	0.53		10.75	10.06	2	2	1.63	1.90
CSID	10.06	11.37	2	1	0.16		10.15	10.03	2	2	1.96	2.75
C1	9.07		1			9.90		2	1.09			
XC2	36.58		2	1.82		36.66		1				
XC3	11.94		2	0.82		11.55		1				
XC4	12.16		2	1.08		11.57		1				
XC5	12.07		2	0.82		11.43		1				
XC6	12.25		2	0.18		12.08		1				
XC7	13.61		2	0.97		13.06		1				
XT1	16.07		1			14.90		1				
XT2	19.09		1			16.38		1				
XT3	16.34		1			17.84		1				
XT4	18.46		1			16.98		1				
XT5	20.29		1			18.92		1				
XT6	19.21		1			18.53		1				
XT7	20.44		1			19.10		1				
XT8	20.76		1			19.43		1				
XT9	210.00		1			20.18		1				
XT10	21.84		1			21.14		1				
XT11	23.01		1			22.37		1				
XT12						24.76		1				
XL1						27.83		1				
XL2	28.00		1			27.69		1				
XL3	27.93		1			28.70		1				
XL4	27.86		1			28.67		1				

WINNEWUCCA LAKE, CONTINUED

Dimension	MALES						FEMALES					
	Mean		n	Std. Dev.		Mean		n	Std. Dev.			
	left	right		left	right	left	right		left	right		
XL5	29.82		1			28.41		1				
S1	31.78		1			31.81		1				
SML						106.68		1				
HML	301.00	319.50	1	2		14.85	286.67	285.75	3	2	9.71	7.42
HEB	54.00	58.00	1	1			57.67	57.75	3	2	2.47	1.77
HHH	43.15	44.04	1	1			43.63	43.61	2	2	3.39	1.82
HMLD	20.13	21.69	1	2		0.84	19.80	18.58	2	1	1.73	
HAPD	19.53	21.06	1	2		1.02	17.91	18.15	2	2	2.02	.62
HAB	42.49		1				43.17	41.48	3	2	1.97	.28
RML	226.50	267.50	1	1			221.50	230.00	2	1	4.95	
RMLD	15.31	13.66	1	1			14.89	16.83	2	1	1.85	
RAPD	11.56	11.57	1	1			11.32	10.21	2	1	1.42	
RMLH	21.86	21.60	1	1			20.83		1			
RAPH	22.33	22.23	1	1			21.72		1			
RAB	25.50	25.18	1	1			27.84	26.28	1	1		
UML	269.75		2			28.64	244.00	246.00	1	1		
UMLD	12.18		2			0.57	11.41		1	.		
UAPD	13.08		2			0.51	11.67		1	.		
FML	447.50		2			31.82	390.00	407.50	1	1		
FBL	443.50		2			33.23		402.00		1		
FEB	80.75	74.00	2	1		8.13		75.50		1		
FAB	71.38	64.86	2	1		7.37		67.23		1		
FHD	48.06		2			4.96	43.57	45.08	1	1		
FMLD	26.22		2			2.55		22.86		1		
FAPD	29.33		2			4.93		23.19		1		
TML	371.75	344.50	2	1		37.83	330.25		2		.35	
TFL	364.75	343.00	2	1		32.88	326.50		1			
TPB	76.25	71.50	2	1		8.84	71.50		1			
TPAB	74.25	69.81	2	1		8.39	69.76		1			
TMLD	21.23	20.74	2	1		2.52	19.72		1			
TAPD	28.69	24.69	2	1		2.72	25.21		1			
FIML	348.00		2			19.80	314.00		2		2.83	
BIB							262.00		1			
IBL							159.00	145.00	1	1		
ACH	49.31		1					50.57	1			
TCH	70.00		1				74.00		1			
TTB	29.05	31.29	1	2		1.55	27.88		1			

MONTAGUE

Dimension	MALES					FEMALES						
	Mean		n	Std. Dev.		Mean		n	Std. Dev.			
	left	right		left	right	left	right		left	right		
BBH	139.43		7	3.74		133.09		11	6.79			
GBL	180.86		7	9.55		166.73		11	6.20			
EUB	140.29		7	6.18		136.54		11	7.09			
UFH	80.87		7	3.07		75.41		11	5.08			
NAH	31.06		7	1.82		27.86		11	1.12			
NAW	25.47		7	2.61		25.16		11	1.37			
ZYG	138.43		7	3.51		129.27		11	5.66			
JNB	26.36		8	1.68		24.21		9	2.61			
CML	152.33	151.90	9	10	5.93	7.28	138.50	136.91	10	11	8.65	7.20
CAPD	12.05	11.84	9	10	1.27	1.47	9.66	10.33	10	11	0.87	1.39
CSID	10.59	10.73	9	10	0.96	1.32	8.43	9.11	10	11	0.78	1.31
C1	10.90		9	0.85		10.12		11	1.41			
XC2	36.67		9	2.24		35.84		11	2.42			
XC3	12.66		9	1.46		12.60		11	0.82			
XC4	12.67		9	1.06		12.31		11	0.77			
XC5	12.51		9	0.99		12.05		11	0.72			
XC6	12.90		10	0.96		12.47		11	1.04			
XC7	14.38		10	0.88		13.77		11	0.76			
XT1	16.31		9	0.91		15.38		11	0.65			
XT2	17.81		9	0.74		16.54		11	0.43			
XT3	18.11		9	0.69		16.73		11	0.63			
XT4	18.49		10	1.01		17.57		11	0.70			
XT5	18.72		10	1.31		17.95		11	0.51			
XT6	19.68		10	1.01		18.05		11	0.63			
XT7	20.27		10	1.23		18.90		11	0.74			
XT8	20.73		10	0.87		19.60		11	0.72			
XT9	21.33		10	1.39		19.79		11	0.76			
XT10	22.32		10	1.30		20.64		10	0.89			
XT11	23.02		10	1.08		21.19		11	1.37			
XT12	27.23		10	6.97		23.40		11	1.78			
XL1	25.71		9	1.04		24.77		11	1.14			
XL2	26.41		10	1.21		26.14		11	1.31			
XL3	27.09		10	1.48		26.85		11	1.53			
XL4	28.18		10	1.67		27.77		11	1.36			

MONTAGUE, CONTINUED

Dimension	MALES						FEMALES					
	Mean		<i>n</i>		Std. Dev.		Mean		<i>n</i>		Std. Dev.	
	left	right			left	right	left	right			left	right
XL5	28.31		10		1.30		28.18		11		1.81	
S1	30.03		8		1.81		29.24		11		2.37	
SML	109.66		7		8.80		101.37		10		9.09	
HML	322.88	324.15	8	10	16.27	12.96	301.91	306.68	11	11	10.53	11.43
HEB	58.83	59.50	9	10	3.22	2.67	51.61	53.20	9	10	2.93	3.71
HHD	44.87	44.98	8	10	2.67	2.45	39.58	39.75	11	11	1.47	1.78
HMLD	20.88	21.30	9	10	2.81	1.69	19.32	19.48	11	11	1.78	1.80
HAPD	20.33	20.39	9	10	1.77	1.49	18.40	19.33	11	11	1.34	1.24
HAB	41.41	42.24	8	10	2.49	1.71	37.61	38.40	10	11	2.43	2.45
RML	254.17	254.61	9	9	9.33	8.63	237.11	237.00	9	9	7.11	9.55
RMLD	13.05	13.11	9	9	1.24	1.11	13.61	13.25	9	9	1.69	1.79
RAPD	11.26	11.63	9	9	0.54	0.92	10.56	10.38	9	9	0.86	1.05
RMLH	21.12	20.89	10	10	1.33	0.85	18.28	18.63	9	9	1.68	1.31
RAPH	21.29	21.43	9	10	1.29	1.22	19.05	18.98	7	8	1.12	1.16
RAB	25.60	25.42	9	9	1.49	1.57	23.28	23.45	10	10	1.63	1.71
UML	272.88	273.25	8	8	10.43	7.27	251.55	253.86	11	11	10.13	9.17
UMLD	12.59	13.16	7	8	0.92	1.20	11.55	12.25	11	11	1.12	1.32
UAPD	15.01	14.40	7	8	2.30	1.62	13.04	13.67	11	11	1.37	1.20
FML	455.88	455.83	8	9	16.13	14.07	424.80	427.05	10	11	17.57	16.07
FBL	452.00	451.33	8	9	14.92	12.60	419.40	421.82	10	11	16.76	15.98
FEB	79.42	78.56	6	9	2.85	3.05	69.22	69.60	9	10	4.80	4.74
FAB	68.69	68.49	7	8	2.67	2.38	59.44	58.97	10	11	5.15	4.20
FHD	45.46	45.66	7	9	2.27	1.94	41.21	40.90	10	11	2.38	2.17
FMLD	25.79	25.83	8	9	2.53	1.92	24.34	24.03	10	11	2.02	1.81
FAPD	28.60	29.14	8	9	2.51	2.88	25.27	25.84	10	11	2.92	2.02
TML	387.45	385.30	10	10	12.90	13.43	356.68	356.70	11	10	14.89	15.93
TFL	382.82	380.30	10	10	13.07	13.25	353.05	353.20	11	10	14.61	16.02
TPB	73.06	72.63	8	8	2.37	2.71	67.50	65.88	7	8	3.00	4.47
TPAB	70.07	70.81	8	8	2.12	2.49	64.66	63.37	7	8	3.18	4.30
TMLD	21.36	22.99	10	10	1.67	1.58	19.54	20.46	10	10	1.76	1.56
TAPD	27.84	28.01	10	10	2.94	3.07	23.62	23.19	10	10	1.53	1.55
FIML	369.70	370.71	5	7	11.00	12.56	344.39	345.58	9	6	19.02	19.45
BIB	262.19		8		12.41		257.73		11		12.53	
IBL	154.14	152.88	7	8	3.72	4.16	147.18	149.00	11	10	7.55	7.85
ACH	51.05	49.46	10	10	1.99	2.23	47.02	45.90	11	11	2.01	1.92
TCH	66.06	66.69	8	8	3.63	3.61	59.05	58.73	11	11	3.91	3.62
TTB	28.89	29.45	9	10	2.45	2.36	26.07	25.95	10	11	1.52	1.56

CHACO CANYON

Dimension	MALES						FEMALES					
	Mean		n	Std. Dev.		Mean		n	Std. Dev.			
	left	right		left	right	left	right		left	right		
BBH	140.40		5	5.77		137.25		8	5.65			
GBL	166.80		5	10.57		159.11		9	11.90			
EUB	148.00		5	11.20		151.00		9	10.16			
UFH	81.93		6	7.51		80.62		8	5.15			
NAH	28.11		6	2.99		26.59		8	2.85			
NAW	24.63		6	.49		23.85		9	1.33			
ZYG	134.40		5	6.88		130.25		8	4.89			
JNB	27.76		4	4.48		21.60		12	1.87			
CML	156.50	158.30	4	5	13.03	8.52	139.00	139.21	13	14	8.03	9.66
CAPD	10.62	11.33	4	5	1.15	0.75	9.19	9.53	13	14	0.64	0.67
CSID	8.52	9.62	4	5	1.08	0.82	7.74	7.76	13	14	0.88	0.83
C1	10.73		4	1.53		10.42		14	1.49			
XC2	36.15		7	4.36		34.29		15	2.79			
XC3	13.77		7	1.00		12.30		15	1.25			
XC4	13.60		6	1.01		12.25		14	1.14			
XC5	12.58		7	1.05		11.78		15	1.20			
XC6	13.33		8	1.15		12.01		15	0.93			
XC7	14.31		7	1.39		13.77		16	1.24			
XT1	15.95		7	1.70		15.43		15	1.09			
XT2	18.69		5	1.35		16.95		16	1.24			
XT3	18.27		6	1.44		16.72		16	0.82			
XT4	18.56		4	1.48		16.99		16	0.79			
XT5	19.24		6	1.60		17.59		16	1.02			
XT6	20.04		7	1.24		18.13		16	1.01			
XT7	20.49		6	0.94		18.41		16	0.95			
XT8	21.44		6	1.39		18.78		16	0.91			
XT9	22.00		6	1.28		19.58		16	1.08			
XT10	22.48		8	1.72		20.49		16	1.14			
XT11	23.30		5	1.60		21.34		15	0.93			
XT12	25.35		5	2.35		22.93		15	1.56			
XL1	26.20		7	1.91		24.44		15	1.41			
XL2	27.26		7	2.38		25.32		16	1.51			
XL3	28.16		6	1.97		26.12		15	1.40			
XL4	28.80		7	2.09		27.30		15	1.62			

CHACO CANYON, CONTINUED

Dimension	MALES						FEMALES					
	Mean		n	Std. Dev.		Mean		n	Std. Dev.			
	left	right		left	right	left	right		left	right		
XL5	28.88		8	1.76		27.70		15	1.64			
S1	31.51		7	2.66		29.39		16	2.43			
SML	109.31		5	9.92		101.03		6	10.17			
HML	313.38	311.64	4	7	21.18	17.48	286.03	291.27	16	17	13.58	12.79
HEB	58.20	59.21	5	7	2.20	4.56	52.22	52.94	16	16	2.71	3.30
HHD	42.88	43.09	4	7	1.91	3.03	37.25	37.21	16	17	2.10	2.15
HMLD	21.43	23.15	4	7	1.15	1.32	20.01	20.57	16	17	1.81	1.89
HAPD	19.23	20.12	4	7	1.22	1.40	17.85	17.90	16	16	1.13	1.21
HAB	41.29	40.36	5	8	0.49	1.97	36.60	36.21	16	16	2.09	1.66
RML	244.13	251.00	4	5	15.93	9.82	223.86	225.38	14	16	11.60	10.01
RMLD	13.75	15.54	4	6	1.25	1.17	12.27	12.62	14	16	1.43	1.12
RAPD	11.70	11.51	4	6	0.27	0.90	10.44	10.65	14	16	0.79	1.07
RMLH	20.03	20.79	6	7	1.54	1.32	18.24	18.60	11	15	1.13	1.08
RAPH	20.23	20.94	6	6	1.52	1.32	18.87	19.09	12	14	1.16	1.15
RAB	23.83	25.39	6	6	2.33	1.40	22.11	22.54	15	16	1.33	1.53
UML	260.63	264.88	4	4	17.41	10.73	237.04	242.08	14	13	9.41	10.41
UMLD	12.49	13.62	4	4	0.31	0.51	11.42	11.20	14	14	0.75	0.84
UAPD	14.23	14.79	4	4	1.97	1.56	12.77	13.36	14	14	1.30	1.22
FML	448.42	435.60	6	5	25.95	29.38	414.82	412.80	14	15	19.54	19.28
FBL	444.00	431.00	6	5	26.32	29.01	413.00	409.00	13	15	17.37	19.03
FEB	79.92	80.13	6	4	4.15	2.32	70.54	70.29	13	14	2.96	3.24
FAB	67.73	65.92	6	5	5.72	6.54	60.11	59.67	13	14	2.06	2.19
FHD	43.75	42.85	7	5	3.22	3.16	37.78	37.94	15	17	2.11	1.91
FMLD	25.24	25.20	6	5	1.70	1.48	23.15	23.18	15	16	1.80	1.75
FAPD	30.09	28.54	6	5	1.54	2.19	25.52	25.21	15	16	2.10	1.82
TML	372.79	374.40	7	5	22.47	23.80	348.39	345.07	14	14	16.74	17.00
TFL	369.39	370.50	7	5	22.52	22.49	345.16	341.84	14	14	16.72	17.31
TPB	73.79	73.08	7	6	5.93	2.87	65.54	64.47	14	15	2.09	2.01
TPAB	71.09	69.86	7	6	5.36	3.35	63.13	62.50	14	14	2.30	1.98
TMLD	22.49	23.92	6	5	1.72	2.26	20.11	20.30	14	13	1.93	2.06
TAPD	28.89	27.25	6	5	2.18	2.74	26.03	24.77	14	13	2.88	1.72
FIML	372.50	373.60	5	5	16.95	11.09	336.42	335.27	12	13	16.81	17.58
BIB	272.50		6		13.22		260.34		16		15.31	
IBL	153.20	153.60	5	5	8.81	4.62	144.53	144.00	15	14	7.38	7.09
ACH	50.00	48.88	6	7	3.20	3.74	43.51	43.43	17	17	2.30	2.16
TCH	65.00	66.25	6	4	6.03	5.68	61.33	59.92	9	12	4.95	5.08
TTB	27.62	27.19	3	3	0.85	0.06	26.14	26.27	2	4	1.75	1.22

CHAMISAL

Dimension	MALES						FEMALES					
	Mean		<i>n</i>	Std. Dev.		Mean		<i>n</i>	Std. Dev.			
	left	right		left	right	left	right		left	right		
BBH	138.17		6	1.60		135.60		5	8.20			
GBL	164.75		4	4.19		165.20		5	10.18			
EUB	143.75		4	4.92		144.60		5	9.99			
UFH	81.43		6	4.16		76.71		4	4.69			
NAH	27.92		6	3.03		26.77		4	1.27			
NAW	25.74		5	0.67		26.55		5	0.96			
ZYG	138.83		6	4.71		130.75		4	6.29			
JNB	24.94		5	1.76		23.25		5	2.09			
CML	148.50	148.21	6	7	8.64	8.02	132.63	129.00	4	5	9.10	8.22
CAPD	10.36	10.49	6	7	1.08	0.57	9.02	9.34	4	5	0.81	0.40
CSID	9.21	9.41	6	7	1.45	1.44	7.72	7.71	4	5	0.49	0.71
C1	11.54		5	1.16		10.88		4	1.43			
XC2	35.80		5	1.34		32.30		4	1.54			
XC3	13.51		5	0.66		11.14		4	0.35			
XC4	12.73		4	0.82		10.41		5	0.66			
XC5	12.53		5	1.41		10.59		5	1.11			
XC6	12.61		5	0.49		10.74		5	0.38			
XC7	13.97		5	0.55		12.59		5	0.66			
XT1	16.16		6	0.39		14.37		5	0.83			
XT2	17.73		6	0.48		15.60		5	0.79			
XT3	18.09		6	1.20		15.37		5	1.06			
XT4	17.95		6	1.21		15.89		5	1.29			
XT5	18.43		6	0.89		16.45		5	1.16			
XT6	18.84		6	1.25		17.07		5	1.01			
XT7	19.43		6	1.07		17.41		5	0.94			
XT8	19.93		6	1.02		18.46		4	0.61			
XT9	20.24		7	0.95		19.05		4	0.87			
XT10	21.53		7	1.16		19.80		4	0.72			
XT11	22.14		7	0.98		20.44		5	1.16			
XT12	23.33		7	1.32		22.18		5	0.72			
XL1	24.93		7	1.50		23.29		5	0.60			
XL2	26.21		6	1.52		24.22		5	0.87			
XL3	27.22		6	0.96		25.15		5	0.92			
XL4	28.58		6	1.12		25.45		5	1.89			

CHAMISAL, CONTINUED

Dimension	MALES						FEMALES					
	Mean		n	Std. Dev.		Mean		n	Std. Dev.			
	left	right		left	right	left	right		left	right		
XL5	28.60		6	1.71		26.57		5	1.51			
S1	29.86		7	1.98		27.83		5	1.73			
SML	110.27		5	7.92		97.56		3	12.77			
HML	306.67	308.21	6	7	12.31	10.40	281.25	284.63	4	4	24.78	22.59
HEB	58.92	59.00	6	6	3.22	3.03	53.00	53.88	4	4	3.72	3.38
HHD	43.31	44.36	7	7	1.99	1.92	37.86	37.44	5	3	2.70	3.02
HMLD	20.77	20.96	7	7	1.96	1.88	20.12	19.63	4	4	1.23	1.97
HAPD	18.31	19.06	7	7	1.38	1.29	16.67	17.16	4	4	1.44	1.61
HAB	39.78	41.01	6	6	3.35	2.32	36.93	37.62	4	4	1.61	1.92
RML	239.00	242.92	7	6	14.02	16.72	210.00	216.75	3	4	23.52	19.21
RMLD	13.07	13.53	7	6	0.64	0.74	11.93	13.57	3	4	0.78	1.58
RAPD	10.94	11.00	7	6	0.96	0.82	9.83	9.96	3	4	0.67	1.23
RMLH	20.96	20.27	7	6	1.96	1.56	18.77	19.06	4	4	1.83	1.68
RAPH	20.75	20.63	6	6	1.26	1.50	19.12	19.41	4	4	1.48	1.83
RAB	24.12	24.20	7	7	0.88	1.43	21.32	21.75	3	3	1.30	1.74
UML	257.08	260.67	6	6	14.74	15.13	228.33	238.00	3	4	22.62	22.93
UMLD	11.98	11.91	7	6	1.16	0.87	11.80	11.41	4	4	1.10	0.95
UAPD	13.56	13.37	7	6	1.17	1.44	12.79	12.30	4	4	0.94	1.00
FML	424.50	419.07	6	7	28.59	28.01	391.60	389.70	5	5	32.53	34.43
FBL	421.83	417.00	6	7	28.21	27.59	387.40	386.20	5	5	31.79	33.67
FEB	79.50	77.93	5	7	6.09	4.94	67.50	67.38	2	4	4.95	5.65
FAB	69.30	68.38	5	7	3.87	3.86	60.23	58.52	4	5	1.90	5.29
FHD	43.26	43.06	7	7	2.49	2.22	37.36	37.07	5	5	1.94	1.58
FMLD	24.01	25.44	6	7	2.47	2.85	23.24	22.33	5	5	0.95	0.91
FAPD	27.40	26.52	6	7	2.47	1.80	22.73	22.97	5	5	1.87	1.68
TML	349.92	351.25	6	6	22.41	20.21	320.80	315.00	5	4	27.08	18.96
TFL	347.17	348.33	6	6	22.85	21.23	313.00	311.43	4	4	29.04	19.42
TPB	74.50	73.50	5	6	4.30	4.97	63.30	63.38	5	4	3.03	4.50
TPAB	71.81	71.25	5	6	3.64	4.13	61.46	62.31	5	4	2.93	3.79
TMLD	21.35	23.44	5	6	2.45	2.24	17.96	19.02	5	4	1.11	1.62
TAPD	26.90	27.90	5	6	4.53	3.14	22.84	22.32	5	4	2.83	1.21
FIML	346.40	345.70	5	5	23.18	21.57	308.25	299.50	4	2	22.49	27.58
BIB	261.67		6	14.53		253.13		4	13.43			
IBL	146.25	147.67	4	6	10.28	7.23	139.50	140.33	4	3	8.96	10.79
ACH	48.86	48.17	6	6	2.61	2.25	43.56	43.06	4	5	1.46	1.71
TCH	61.88	64.40	4	5	2.32	2.82	53.67	54.50	3	3	3.21	4.44
TTB	29.24	28.78	4	5	2.82	2.47	24.80	25.42	3	3	1.32	1.46

GALLINA SPRINGS

Dimension	MALES						FEMALES					
	Mean		n	Std. Dev.		Mean		n	Std. Dev.			
	left	right		left	right	left	right		left	right		
BBH	142.60		5	5.68		138.67		3	5.51			
GBL	166.00		5	10.65		158.00		3	10.82			
EUB	140.00		5	2.45		138.67		3	2.08			
UFH	79.62		5	7.16		81.58		2	3.52			
NAH	25.17		3	1.04		24.96		2	2.31			
NAW	25.08		5	1.65		22.60		3	0.85			
ZYG	134.40		5	5.55		129.50		2	2.12			
JNB	27.26		4	1.03		21.87		1				
CML	151.00	150.10	5	5	18.83	18.49	135.00	139.17	1	3	5.75	
CAPD	10.33	10.90	5	5	0.67	1.34	9.32	9.59	1	3	0.34	
CSID	9.61	9.59	5	5	1.77	2.11	7.95	7.47	1	3	0.76	
C1	10.74		6	1.12		10.69		3	1.17			
XC2	32.93		5	2.30		34.34		2	3.17			
XC3	11.59		5	1.43		12.01		2	0.67			
XC4	11.69		6	1.34		10.85		3	0.36			
XC5	11.74		6	1.35		10.10		3	0.42			
XC6	12.13		8	0.54		11.63		3	0.62			
XC7	13.44		8	0.79		12.94		2	0.95			
XT1	15.32		7	1.24		14.42		2	1.97			
XT2	17.08		7	1.38		16.20		2	0.70			
XT3	16.83		7	1.57		16.26		2	1.37			
XT4	17.27		7	1.38		16.99		2	1.80			
XT5	17.27		7	2.51		17.48		2	1.68			
XT6	18.27		7	1.47		17.32		2	1.07			
XT7	19.14		6	1.36		18.40		2	0.85			
XT8	19.88		7	1.55		18.49		3	1.50			
XT9	20.76		7	1.54		20.01		3	1.96			
XT10	21.68		7	1.65		20.53		3	2.00			
XT11	22.80		7	1.85		20.98		4	1.76			
XT12	23.62		8	2.17		22.50		4	1.87			
XL1	24.32		8	1.33		23.87		4	2.07			
XL2	25.76		8	1.56		24.37		4	2.57			
XL3	25.97		7	2.30		25.50		4	3.35			
XL4	26.77		7	2.22		27.09		4	3.41			

GALLINA SPRINGS, CONTINUED

Dimension	MALES						FEMALES					
	Mean		<i>n</i>		Std. Dev.		Mean		<i>n</i>		Std. Dev.	
	left	right			left	right	left	right			left	right
XL5	28.05		7		2.57		27.31		4		2.74	
S1	29.97		5		0.50		29.31		4		3.52	
SML	101.95		3		3.01		101.57		2		11.60	
HML	306.38	313.33	8	6	19.37	21.24	290.50	289.83	2	3	20.51	16.65
HEB	123.43	58.08	7	6	176.20	2.60	53.00	51.83	2	3	1.41	2.02
HHH	42.70	42.20	6	7	1.99	3.55	40.03	39.29	2	3	2.26	2.24
HMLD	21.32	20.53	8	6	1.45	1.82	20.64	20.11	1	2		2.04
HAPD	19.35	20.69	8	6	1.35	2.29	19.54	18.68	1	2		2.48
HAB	40.36	40.63	7	6	1.76	1.43	38.74	37.14	2	2	1.35	.06
RML	240.29	240.00	7	5	17.58	20.75	228.00	222.83	1	3		7.59
RMLD	13.06	13.47	7	5	1.03	1.82	12.29	13.87	1	3		1.58
RAPD	11.35	11.19	7	5	0.39	1.03	10.58	10.42	1	3		1.17
RMLH	20.52	20.57	7	5	0.84	0.43	18.90	19.15	2	3	0.89	0.55
RAPH	21.39	20.95	6	5	1.06	0.51	19.45	19.59	2	3	0.40	0.51
RAB	24.38	23.82	6	7	1.37	1.41	24.05	22.51	1	3		0.47
UML	251.36	259.92	7	6	10.94	18.12	245.00	239.13	1	4		6.14
UMLD	12.35	12.35	7	6	0.43	0.87	12.37	11.43	1	4		0.97
UAPD	13.91	13.65	7	6	1.32	0.89	14.75	13.90	1	4		1.84
FML	426.42	419.43	6	7	22.37	24.48	417.83	410.63	3	4	13.16	13.55
FBL	424.60	416.92	5	6	24.64	27.13	414.00	408.17	3	3	12.29	14.84
FEB	76.50	75.70	5	5	4.95	4.02	71.38	70.33	4	3	1.18	1.61
FAB	66.27	66.90	6	6	5.10	3.38	61.64	62.02	4	3	2.31	2.04
FHD	43.18	42.40	6	7	2.37	3.15	39.26	39.70	4	4	1.18	1.43
FMLD	25.04	24.18	6	6	1.11	1.29	24.22	23.40	3	4	1.43	1.65
FAPD	29.40	28.43	6	7	1.71	2.36	24.93	25.26	3	4	1.13	2.42
TML	363.10	355.00	5	7	23.14	21.11	346.25	360.00	4	1	7.85	
TFL	360.90	352.67	5	7	23.66	21.91	343.02	355.00	4	1	8.02	
TPB	73.50	71.50	4	6	1.29	2.43	67.00	67.33	2	3	0.71	3.21
TPAB	71.22	69.66	4	6	1.69	2.64	66.15	64.98	2	3	0.95	2.68
TMLD	20.84	22.66	5	7	1.19	2.65	19.36	22.25	4	1	1.43	
TAPD	27.98	27.03	5	7	3.09	3.28	25.84	24.29	4	1	1.93	
FIML	336.33	359.33	3	3	1.53	26.08	347.50	347.00	1	1		
BIB	270.00		4		9.45		265.00		4		4.24	
IBL	146.75	146.60	4	5	2.22	4.04	142.33	142.50	3	4	1.15	3.00
ACH	47.79	48.35	6	5	2.65	2.26	44.83	45.13	4	4	0.98	1.88
TCH	60.33	62.25	3	4	4.51	3.30	56.00	57.00	3	1	0.00	
TTB	28.04	28.76	5	4	1.67	1.65	26.18	26.48	3	2	0.39	0.23

HAWIKUH

Dimension	MALES						FEMALES					
	Mean		n	Std. Dev.		Mean		n	Std. Dev.			
	left	right		left	right	left	right		left	right		
BBH	132.14		14	3.57		127.25		24	4.33			
GBL	169.85		13	6.49		156.96		23	8.47			
EUB	131.43		14	4.27		132.35		23	5.73			
UFH	79.32		14	3.32		74.65		26	4.14			
NAH	30.33		14	2.38		27.06		25	2.07			
NAW	24.47		14	1.73		24.77		25	1.46			
ZYG	130.93		14	5.00		126.50		24	4.44			
JNB	26.84		14	3.82		21.82		23	3.20			
CML	151.03	149.47	17	17	8.43	10.70	136.18	132.95	31	31	6.06	6.42
CAPD	10.73	11.00	18	17	0.70	0.91	8.82	9.06	31	31	0.96	0.73
CSID	8.78	9.10	18	17	0.98	1.34	7.84	7.85	31	31	0.88	0.97
C1	10.64		15	1.06		9.18		33	0.66			
XC2	34.12		17	2.57		32.36		33	2.04			
XC3	12.77		16	1.26		11.55		33	0.91			
XC4	12.82		15	1.19		11.52		33	0.80			
XC5	12.45		16	1.11		11.58		32	0.75			
XC6	12.72		17	1.02		11.72		32	0.65			
XC7	14.66		19	2.42		13.23		31	0.83			
XT1	16.25		16	0.85		14.77		33	0.78			
XT2	17.73		16	0.97		16.60		32	2.37			
XT3	17.87		15	0.93		16.05		29	0.76			
XT4	17.97		13	0.95		16.28		27	1.04			
XT5	18.58		13	1.14		16.95		28	0.86			
XT6	19.38		14	1.05		17.67		31	0.94			
XT7	19.79		14	1.16		18.01		30	0.84			
XT8	20.31		14	1.43		18.64		31	0.98			
XT9	20.85		15	1.83		19.10		32	0.97			
XT10	21.59		18	1.23		19.88		33	1.10			
XT11	22.10		19	1.23		20.34		34	0.99			
XT12	23.89		19	1.35		22.39		34	1.20			
XL1	25.31		20	1.14		24.15		34	0.96			
XL2	25.93		19	1.12		24.80		36	1.09			
XL3	26.42		19	1.05		25.60		36	1.17			
XL4	27.90		19	1.31		26.37		36	1.25			

HAWIKUH, CONTINUED

Dimension	MALES						FEMALES					
	Mean		n		Std. Dev.		Mean		n		Std. Dev.	
	left	right			left	right	left	right			left	right
XL5	28.33		20		1.57		27.00		36		1.59	
S1	29.35		21		1.85		27.91		34		1.75	
SML	106.19		15		7.13		102.37		27		9.48	
HML	304.46	305.70	23	20	12.87	12.84	284.02	288.72	31	34	11.10	10.77
HEB	57.28	58.13	23	20	1.76	2.04	52.03	52.30	35	33	2.37	1.70
HHD	41.73	42.41	20	19	1.92	2.09	37.28	37.14	32	34	1.79	1.58
HMLD	19.51	20.04	23	20	1.33	1.75	20.21	20.88	33	34	1.34	1.65
HAPD	18.46	18.83	23	20	1.08	0.98	17.40	17.79	33	34	1.08	0.92
HAB	38.17	38.27	20	18	1.68	1.44	36.68	36.48	34	34	1.85	1.48
RML	237.72	238.94	18	18	11.59	11.67	219.85	221.88	29	34	8.58	9.46
RMLD	12.52	13.02	19	19	0.93	0.78	12.30	13.05	30	34	1.02	1.05
RAPD	10.49	10.89	19	19	0.58	0.58	10.03	10.33	30	34	0.66	0.72
RMLH	19.82	20.10	18	19	1.14	0.83	18.24	18.46	31	33	1.03	0.79
RAPH	20.57	20.69	17	19	1.17	0.86	18.96	18.89	31	34	0.89	0.87
RAB	23.88	24.06	17	19	1.32	1.39	22.30	22.27	30	34	1.16	1.15
UML	253.88	256.78	16	18	12.40	11.18	235.29	237.54	29	34	8.69	9.40
UMLD	11.47	11.88	16	18	1.04	0.86	11.28	11.43	30	34	0.85	0.78
UAPD	13.38	13.66	16	18	1.17	0.84	12.95	13.11	30	34	1.37	1.37
FML	428.17	426.00	24	23	19.52	20.29	400.00	398.73	34	35	12.79	13.51
FBL	424.77	422.87	24	23	18.69	19.40	395.56	394.27	34	35	13.20	13.30
FEB	76.89	76.98	22	22	3.33	3.16	68.51	69.10	34	35	2.56	2.77
FAB	66.68	66.47	22	22	3.13	2.83	58.09	59.02	34	35	2.56	2.78
FHD	42.70	42.60	24	24	1.73	1.62	37.93	38.17	34	36	1.61	1.54
FMLD	25.52	25.46	24	23	2.02	1.91	22.75	22.62	34	35	1.52	1.26
FAPD	27.57	27.90	24	23	1.79	2.00	24.31	24.74	34	35	1.83	1.67
TML	361.87	360.40	19	20	17.81	18.55	333.83	332.78	33	32	13.00	13.27
TFL	358.42	357.45	19	20	17.50	18.66	329.37	329.03	32	32	13.25	13.28
TPB	72.50	71.92	19	19	3.08	2.99	63.72	64.02	32	32	2.17	2.45
TPAB	70.48	69.94	19	19	2.84	2.94	61.93	62.22	32	32	2.22	2.76
TMLD	21.96	22.06	18	19	1.60	1.34	19.57	19.91	33	31	1.59	1.48
TAPD	27.43	26.60	18	19	1.67	2.22	23.55	22.85	33	31	1.54	1.69
FIML	347.07	348.81	15	16	17.80	16.83	323.62	323.30	29	28	12.46	14.27
BIB	264.33		21		9.56		258.18		33		11.43	
IBL	149.40	147.59	15	17	5.47	5.65	138.20	137.62	30	29	5.96	5.41
ACH	47.62	47.61	24	23	1.90	2.45	42.99	43.24	35	36	1.85	1.94
TCH	65.71	65.00	17	19	4.22	3.57	57.50	58.35	29	26	3.35	3.05
TTB	27.23	27.53	18	20	1.31	1.47	24.88	25.21	29	28	1.41	1.31

MIMBRES

Dimension	MALES						FEMALES					
	Mean		n	Std. Dev.		Mean		n	Std. Dev.			
	left	right		left	right	left	right		left	right		
BBH	142.80		5	5.89								
GBL	169.00		5	7.71								
EUB	139.20		5	4.76								
UFH	82.48		4	4.67								
NAH	25.47		3	1.60								
NAW	24.00		5	2.33								
ZYG	136.75		4	5.91								
JNB	23.65		5	2.71		23.92		2	0.69			
CML	151.30	149.36	5	7	4.92	4.35	149.00	150.00	1	1		
CAPD	11.70	11.32	5	7	2.73	0.65	10.85	9.25	1	1		
CSID	10.06	9.67	5	7	1.85	1.51	10.23	10.14	1	1		
C1	10.90		4	1.27		10.06		2	1.98			
XC2	34.53		4	1.83		34.33		2	3.15			
XC3	13.12		4	0.82		11.92		2	0.10			
XC4	12.33		4	0.81		12.00		2	0.71			
XC5	11.32		4	0.73		10.57		1				
XC6	11.79		5	0.83		11.75		1				
XC7	13.48		5	0.78		13.86		1				
XT1	16.01		4	0.97		15.15		1				
XT2	18.00		6	0.68		15.98		1				
XT3	17.62		6	1.32		16.70		1				
XT4	18.36		6	0.43		16.55		2	0.13			
XT5	18.95		6	0.60		16.75		3	0.10			
XT6	19.40		6	0.61		17.45		3	0.15			
XT7	20.07		7	0.82		17.71		3	0.62			
XT8	20.84		8	0.65		17.90		3	0.37			
XT9	21.41		8	0.68		19.79		3	0.32			
XT10	22.03		9	1.21		20.27		2	0.74			
XT11	22.62		9	1.08		21.09		2	0.64			
XT12	24.13		9	1.26		22.69		2	1.57			
XL1	25.98		9	0.85		24.42		2	2.31			
XL2	26.74		9	0.71		25.57		2	1.01			
XL3	27.58		9	1.07		26.23		2	1.71			
XL4	28.38		9	0.87		25.91		1				

MIMBRES, CONTINUED

Dimension	MALES						FEMALES					
	Mean		n	Std. Dev.		Mean		n	Std. Dev.			
	left	right		left	right	left	right		left	right		
XL5	29.32		9	1.22		26.85		1				
S1	30.36		8	1.28		30.23		3	1.50			
SML	112.86		5	12.67		104.77		2	4.96			
HML	310.93	312.08	7	6	11.71	13.85	295.50	307.50	3	2	5.68	10.61
HEB	57.30	58.33	5	6	3.67	2.07	53.83	57.50	3	1	4.25	
HHD	44.42	44.90	6	7	1.65	1.25	37.72	38.88	3	2	2.47	1.82
HMLD	20.26	21.08	7	7	1.39	1.33	20.12	19.79	3	2	2.65	3.40
HAPD	19.37	19.65	7	7	1.87	0.88	17.32	18.74	3	2	1.32	0.72
HAB	39.44	40.15	5	6	2.17	1.01	37.60	40.57	4	1	3.02	
RML	243.75	244.36	8	7	10.51	10.84	230.67	235.50	3	2	11.93	4.95
RMLD	12.95	13.86	8	7	1.10	0.75	11.63	13.79	3	2	1.27	0.35
RAPD	11.17	11.76	8	7	1.06	0.54	10.56	10.47	3	2	0.93	0.70
RMLH	20.20	20.52	7	8	1.22	1.32	19.58	19.72	4	2	1.42	1.17
RAPH	20.72	20.71	7	8	0.77	1.03	19.85	20.89	4	1	1.20	
RAB	24.99	25.06	8	6	0.85	0.54	22.42	21.69	2	2	0.64	2.46
UML	262.63	261.80	8	5	10.12	10.28	250.83	263.00	3	1	15.91	
UMLD	11.76	12.78	8	5	0.71	0.74	11.18	12.68	3	1	0.45	
UAPD	14.31	14.28	8	5	1.43	0.91	13.31	13.84	3	1	0.91	
FML	436.71	430.94	7	9	10.84	15.16	418.30	404.00	5	2	14.67	5.66
FBL	433.14	427.28	7	9	9.97	14.25	414.60	401.00	5	2	13.94	8.49
FEB	77.00	77.75	6	8	2.92	3.84	72.00	70.00	3	3	5.29	2.65
FAB	67.48	67.55	7	8	2.15	3.76	62.12	60.95	3	3	4.54	1.95
FHD	44.30	44.18	8	9	1.33	1.31	39.44	40.84	5	2	2.40	0.23
FMLD	25.14	25.05	8	9	1.36	1.27	24.52	24.40	5	2	3.05	0.70
FAPD	29.82	29.34	7	9	2.79	2.97	26.76	24.82	5	2	1.98	0.09
TML	364.78	364.33	9	9	8.07	7.30	353.88	359.25	4	4	11.65	16.76
TFL	361.28	360.56	9	9	7.35	6.28	351.14	355.63	4	4	12.93	17.78
TPB	73.61	73.56	9	8	2.90	3.61	67.33	67.67	3	3	4.51	4.04
TPAB	71.90	70.97	9	8	3.12	3.16	65.54	65.85	3	3	4.11	3.16
TMLD	21.78	23.42	9	9	1.83	1.71	18.99	21.00	4	4	1.88	1.19
TAPD	27.54	28.68	9	9	1.63	1.90	25.79	26.25	4	4	2.93	1.78
FIML	356.33	352.86	6	7	2.42	7.01	359.50	343.25	1	2		25.81
BIB	266.14		7	7.73		277.00		2	9.90			
IBL	150.00	151.33	4	3	4.24	3.21	147.00	155.00	1	1		
ACH	50.53	50.23	8	8	1.59	1.66	46.51	43.87	3	2	3.97	4.00
TCH	62.42	67.14	6	7	4.26	4.15	61.00	61.75	1	2		1.77
TTB	29.10	29.54	7	8	2.35	1.69	27.43	27.68	2	3	0.76	0.44

PAA KO

Dimension	MALES						FEMALES					
	Mean		n	Std. Dev.		Mean		n	Std. Dev.			
	left	right		left	right	left	right		left	right		
BBH	137.40		10	7.57		134.50		10	4.40			
GBL	166.20		10	6.75		160.50		10	10.47			
EUB	144.00		10	8.27		142.00		10	7.85			
UFH	80.18		9	2.56		79.02		10	6.86			
NAH	27.01		8	0.67		25.44		6	1.39			
NAW	24.59		10	1.38		24.47		10	1.99			
ZYG	139.44		9	7.02		130.70		10	4.42			
JNB	30.39		9	4.30		24.73		10	2.69			
CML	155.50	149.38	10	8	5.98	12.97	134.25	130.94	8	9	4.75	4.40
CAPD	10.91	11.36	10	8	1.16	1.52	8.94	9.85	8	9	0.76	1.15
CSID	9.03	8.56	10	8	1.25	1.25	8.41	8.36	8	9	1.59	1.27
C1	11.57		10	1.59		10.55		11	1.34			
XC2	36.22		10	3.72		33.19		13	2.71			
XC3	13.12		10	1.21		12.07		13	0.61			
XC4	12.53		11	1.15		11.96		13	0.78			
XC5	12.22		11	1.33		11.12		13	0.99			
XC6	12.44		11	0.97		11.70		13	0.77			
XC7	14.21		11	1.19		13.00		13	0.78			
XT1	15.98		12	1.42		14.79		13	0.84			
XT2	17.40		12	1.28		16.09		13	0.81			
XT3	17.13		11	1.26		16.22		13	0.35			
XT4	17.93		11	1.52		16.62		13	0.42			
XT5	18.56		11	1.35		17.33		13	0.55			
XT6	19.22		11	1.35		17.61		13	0.79			
XT7	19.62		11	1.33		18.14		13	0.78			
XT8	20.18		11	1.03		18.73		13	0.69			
XT9	21.14		10	1.31		19.38		12	0.73			
XT10	22.06		11	1.58		19.96		12	0.86			
XT11	22.57		14	1.40		21.06		14	0.62			
XT12	23.95		13	1.20		22.96		14	1.17			
XL1	25.69		13	1.48		24.68		14	1.15			
XL2	26.60		13	1.15		25.20		14	1.13			
XL3	27.16		12	1.25		25.84		14	0.93			
XL4	28.34		13	1.57		26.51		14	1.46			

PAA KO, CONTINUED

Dimension	MALES						FEMALES					
	Mean		n		Std. Dev.		Mean		n		Std. Dev.	
	left	right			left	right	left	right			left	right
XL5	29.46		13		2.17		26.99		14		1.43	
S1	31.17		11		1.77		28.45		14		2.30	
SML	106.56		10		7.58		100.56		13		9.46	
HML	315.78	317.63	9	12	8.84	9.87	283.58	288.42	12	12	6.02	10.11
HEB	58.83	58.96	9	12	2.63	2.98	52.82	53.32	14	11	2.86	3.01
HHD	43.74	44.60	11	12	2.91	3.31	38.64	38.73	13	12	1.84	1.66
HMLD	21.04	21.59	10	12	2.33	1.85	20.10	20.51	14	12	1.35	1.89
HAPD	19.72	20.47	10	12	1.38	1.32	18.12	18.18	14	12	0.93	1.44
HAB	41.69	41.29	9	11	1.24	1.48	38.99	38.11	13	11	1.53	1.95
RML	243.04	241.45	12	10	10.27	11.91	218.13	215.22	12	9	5.87	8.98
RMLD	13.53	14.55	12	11	1.16	1.71	12.71	13.16	13	11	1.56	1.24
RAPD	11.04	11.66	12	11	0.62	0.83	10.03	10.52	13	11	0.72	0.66
RMLH	20.20	20.57	13	11	0.90	0.62	18.62	18.24	12	8	1.13	0.53
RAPH	20.88	21.00	12	11	0.88	0.95	19.24	18.61	12	9	0.84	0.70
RAB	24.42	24.62	11	11	1.18	1.38	22.56	22.41	14	11	0.61	1.48
UML	255.89	260.50	9	9	10.36	12.01	231.60	233.45	10	10	7.04	7.84
UMLD	11.91	12.60	9	9	0.74	0.64	11.38	11.34	11	11	0.91	0.94
UAPD	14.38	14.10	9	9	1.24	1.06	12.96	13.17	11	11	1.19	1.49
FML	436.33	428.05	12	10	20.71	18.57	393.55	394.04	11	13	12.83	11.99
FBL	430.86	425.93	11	7	19.13	20.65	389.35	388.25	10	10	12.44	12.48
FEB	78.40	78.33	10	9	3.31	3.47	70.72	71.58	9	12	2.79	3.46
FAB	69.16	69.38	10	10	3.58	3.26	61.18	61.74	10	12	1.98	3.10
FHD	43.53	44.10	12	8	2.12	2.53	38.49	38.96	12	11	1.94	1.69
FMLD	25.78	26.11	13	11	2.08	1.70	23.46	23.10	11	13	1.31	1.86
FAPD	28.89	27.84	13	11	2.80	2.54	24.97	24.29	11	13	1.72	1.67
TML	368.05	366.33	11	9	15.21	14.97	329.65	327.42	13	12	8.88	8.69
TFL	363.04	362.62	10	9	16.29	16.05	325.43	324.22	13	12	9.32	8.78
TPB	73.72	74.17	9	9	3.25	3.27	67.00	67.59	12	11	2.17	1.39
TPAB	71.16	71.39	9	9	3.75	3.26	64.76	65.82	12	11	1.74	1.39
TMLD	20.92	23.03	12	11	1.60	1.77	18.98	19.72	12	11	1.00	0.88
TAPD	28.49	26.85	12	11	2.59	2.13	24.93	22.77	12	11	1.80	0.96
FIML	354.56	355.33	9	9	7.04	15.48	317.46	317.77	11	11	9.79	9.72
BIB	272.56		8		12.48		265.12		13		7.98	
IBL	149.00	149.17	9	6	4.97	4.62	142.73	143.54	11	11	3.66	4.80
ACH	48.56	48.48	9	9	2.63	2.44	44.00	43.97	12	13	1.86	2.30
TCH	65.15	65.38	10	12	3.46	3.52	57.79	57.89	12	9	1.92	1.43
TTB	30.49	30.21	9	12	2.04	2.06	27.18	27.60	12	9	1.26	1.47

POTTERY MOUND

Dimension	MALES						FEMALES					
	Mean		<i>n</i>	Std. Dev.		Mean		<i>n</i>	Std. Dev.			
	left	right		left	right	left	right		left	right		
BBH	136.29		14	7.28		132.33		9	5.61			
GBL	169.79		14	9.42		158.78		9	9.18			
EUB	142.64		14	8.34		138.33		9	5.79			
UFH	82.27		14	6.45		76.99		9	5.80			
NAH	27.98		16	3.32		25.52		8	1.82			
NAW	24.82		17	1.89		24.55		11	1.11			
ZYG	137.60		15	8.35		129.00		9	5.83			
JNB	27.33		13	2.22		22.87		14	1.68			
CML	148.89	146.83	18	18	8.01	9.61	134.73	131.81	13	13	3.68	4.29
CAPD	10.30	10.84	18	18	0.83	0.96	9.60	10.00	13	13	0.96	0.67
CSID	8.70	9.27	18	18	1.03	0.92	8.16	8.06	13	13	0.74	0.80
C1	11.05		21	1.35		10.53		13	1.72			
XC2	34.51		23	2.69		32.92		17	2.50			
XC3	12.80		23	1.18		11.57		17	1.00			
XC4	12.66		19	0.94		11.66		15	1.13			
XC5	11.99		20	0.75		11.46		13	1.01			
XC6	12.50		24	0.87		11.70		14	0.74			
XC7	13.86		23	0.81		12.96		14	0.70			
XT1	16.01		23	1.13		14.80		16	0.45			
XT2	17.36		24	0.97		16.45		16	0.51			
XT3	17.53		23	0.86		16.05		16	1.03			
XT4	17.96		22	0.88		16.65		16	0.75			
XT5	18.60		22	1.05		17.09		16	1.03			
XT6	19.31		22	1.02		17.25		16	1.26			
XT7	19.77		22	0.99		17.93		16	1.08			
XT8	20.24		21	1.12		18.63		16	1.02			
XT9	21.10		22	1.11		19.14		15	1.01			
XT10	21.79		23	1.02		19.76		14	0.98			
XT11	22.53		23	1.04		20.72		14	0.87			
XT12	23.73		23	1.25		23.00		14	1.20			
XL1	24.84		24	1.62		24.43		17	1.10			
XL2	25.68		22	1.42		24.97		17	1.44			
XL3	26.17		22	1.25		25.97		17	0.93			
XL4	26.92		22	1.78		26.70		17	1.23			

POTTERY MOUND, CONTINUED

Dimension	MALES						FEMALES					
	Mean		<i>n</i>		Std. Dev.		Mean		<i>n</i>		Std. Dev.	
	left	right			left	right	left	right			left	right
XL5	27.62		23		1.62		27.19		17		1.40	
S1	29.89		23		2.61		28.17		16		1.17	
SML	106.49		14		11.16		102.94		12		6.86	
HML	303.02	303.90	23	21	11.25	12.01	282.03	288.39	17	14	8.41	8.52
HEB	58.26	59.18	23	22	3.34	3.75	52.81	53.46	16	14	2.71	2.96
HHD	42.36	43.25	23	22	2.36	2.45	38.31	38.53	16	16	1.61	1.71
HMLD	19.85	20.48	23	22	1.72	1.64	20.27	20.85	16	15	2.03	2.28
HAPD	18.33	19.40	23	22	1.58	1.74	18.08	18.75	16	15	2.05	1.93
HAB	40.27	39.80	22	22	1.79	2.06	38.42	38.20	17	14	1.74	1.79
RML	237.50	237.28	24	20	9.94	9.76	218.50	221.04	15	14	8.09	6.43
RMLD	12.84	13.63	24	20	1.28	1.29	12.57	13.23	16	13	1.08	1.28
RAPD	10.48	10.71	24	20	0.66	0.95	10.31	10.20	16	13	0.81	0.66
RMLH	20.31	20.94	23	19	1.25	1.23	18.71	18.99	15	14	0.75	0.81
RAPH	20.73	20.73	23	19	1.18	1.06	19.12	19.20	15	13	0.66	0.59
RAB	24.05	24.31	24	23	1.43	1.20	21.86	22.39	16	15	0.98	1.14
UML	256.48	256.10	24	20	11.79	11.22	235.57	238.73	14	15	7.55	5.81
UMLD	11.81	12.49	24	20	1.00	0.85	11.58	11.63	14	14	0.77	0.64
UAPD	13.63	13.79	24	20	1.45	1.09	13.31	13.60	14	14	1.31	1.44
FML	424.81	424.09	21	23	17.05	17.14	395.83	394.66	15	16	10.31	10.26
FBL	424.15	422.30	20	22	15.97	16.49	392.43	391.47	14	16	11.30	10.71
FEB	77.68	77.18	19	20	2.91	3.29	69.81	70.00	13	15	3.19	2.78
FAB	68.06	68.08	19	21	2.71	2.83	60.23	61.09	14	14	2.34	2.11
FHD	42.24	42.37	21	24	2.02	2.07	38.47	38.59	17	16	1.44	1.30
FMLD	24.49	24.94	21	24	1.92	2.20	24.53	23.26	16	16	1.23	1.08
FAPD	27.53	27.57	21	24	1.95	2.38	24.78	24.68	16	16	2.05	1.94
TML	358.73	358.96	20	23	15.87	16.06	330.63	334.07	16	15	13.51	13.35
TFL	355.60	355.79	20	23	15.91	16.26	326.81	329.53	16	15	13.40	13.11
TPB	72.29	72.35	19	20	2.94	3.01	66.29	66.38	14	12	2.87	2.64
TPAB	70.62	70.17	19	20	2.83	3.02	64.50	64.51	14	12	2.46	2.47
TMLD	20.16	22.72	20	23	1.60	1.68	18.54	20.40	16	16	1.36	1.94
TAPD	26.93	27.54	20	23	1.97	2.00	24.75	24.31	16	16	1.39	1.94
FIML	345.36	346.70	14	20	17.52	17.43	323.32	322.83	11	12	11.99	12.66
BIB	263.53		18		9.95		257.23		13		12.20	
IBL	145.81	148.41	16	17	5.67	6.84	142.11	139.70	9	10	5.51	4.52
ACH	47.32	47.76	21	21	2.35	2.24	44.16	44.15	12	14	1.67	1.44
TCH	61.80	63.52	22	22	3.50	3.11	56.90	57.39	15	14	3.05	3.01
TTB	28.43	28.66	22	23	1.64	1.84	25.98	26.04	15	15	1.01	1.12

PUYE

Dimension	MALES						FEMALES					
	Mean		n	Std. Dev.		Mean		n	Std. Dev.			
	left	right		left	right	left	right		left	right		
BBH	137.39		13	4.68		131.36		14	4.85			
GBL	153.40		10	10.46		150.80		10	9.04			
EUB	143.54		13	5.38		138.58		12	5.50			
UFH	76.62		10	2.77		75.56		11	4.11			
NAH	28.15		11	3.55		29.00		12	3.11			
NAW	23.57		13	1.63		23.79		14	1.64			
ZYG	132.75		12	4.14		124.75		12	7.51			
JNB	24.74		9	2.71		20.29		9	2.53			
CML	147.62	145.77	13	13	6.53	7.77	135.21	132.15	14	13	5.27	7.81
CAPD	10.17	10.59	13	13	0.98	0.92	9.00	9.80	14	13	0.79	1.17
CSID	9.26	9.13	13	13	1.33	1.10	7.88	7.80	14	13	0.71	1.05
C1	11.09		15	1.33		10.51		18	1.68			
XC2	33.53		14	2.14		32.40		19	3.55			
XC3	12.08		14	1.11		11.52		19	1.30			
XC4	12.29		14	0.72		11.48		17	0.72			
XC5	12.14		14	0.72		11.42		18	0.73			
XC6	12.32		14	0.82		11.46		21	0.87			
XC7	13.69		14	0.90		13.04		20	0.91			
XT1	15.17		16	0.96		14.33		20	0.97			
XT2	16.63		16	1.01		15.78		20	1.29			
XT3	16.07		13	1.09		16.70		19	4.39			
XT4	16.36		13	0.54		16.29		19	0.82			
XT5	16.93		12	0.70		16.68		21	0.89			
XT6	17.78		13	1.34		17.09		22	0.77			
XT7	18.43		14	0.96		17.48		21	0.85			
XT8	18.67		13	0.91		18.00		20	0.97			
XT9	19.43		12	1.31		18.90		20	0.85			
XT10	20.33		15	1.29		19.66		19	0.97			
XT11	20.85		17	1.40		20.64		20	0.91			
XT12	22.51		17	1.69		22.48		20	0.94			
XL1	24.19		17	1.12		23.61		21	1.05			
XL2	24.92		17	0.97		24.26		23	1.02			
XL3	25.77		17	1.07		24.94		23	0.91			
XL4	26.43		17	1.19		25.70		23	1.11			

PUYE, CONTINUED

Dimension	MALES						FEMALES					
	Mean		<i>n</i>		Std. Dev.		Mean		<i>n</i>		Std. Dev.	
	left	right			left	right	left	right			left	right
XL5	26.68		17		1.17		26.74		23		1.79	
S1	29.18		17		2.10		27.44		23		1.46	
SML	100.37		17		10.28		101.00		19		5.35	
HML	301.41	302.46	16	13	13.29	12.57	280.90	285.78	20	20	10.62	10.50
HEB	54.65	56.04	17	14	3.47	3.17	48.79	49.11	19	18	2.51	2.56
HHD	40.75	41.87	16	13	2.30	2.40	37.40	37.46	21	20	1.57	1.87
HMLD	19.29	20.38	17	13	1.05	1.44	19.71	20.55	20	20	1.64	2.04
HAPD	18.07	19.79	17	13	1.20	1.22	17.43	17.94	20	20	1.69	1.22
HAB	37.32	37.45	17	15	1.82	1.76	34.85	34.62	17	16	1.52	1.44
RML	229.89	235.15	14	13	9.83	11.59	215.11	217.00	18	12	8.49	8.73
RMLD	12.69	13.02	15	13	0.99	1.21	11.69	12.47	18	14	1.11	1.19
RAPD	10.46	11.10	15	13	0.47	0.68	9.99	10.28	18	14	0.53	0.91
RMLH	19.37	19.83	17	13	1.30	1.75	17.44	17.69	18	11	1.21	0.98
RAPH	19.54	20.25	17	13	1.18	1.59	18.02	18.11	17	12	1.30	0.86
RAB	23.72	24.72	16	13	1.37	1.79	22.67	22.71	18	13	1.53	0.96
UML	247.23	251.63	15	15	12.46	13.21	230.15	234.31	13	13	5.98	6.56
UMLD	11.74	12.33	15	15	0.81	1.02	11.33	11.93	13	13	0.75	1.20
UAPD	13.01	13.71	15	15	1.13	1.38	12.38	12.68	13	13	1.27	1.01
FML	420.34	417.50	16	15	22.61	21.54	393.73	393.24	22	21	13.22	12.97
FBL	418.22	414.93	16	15	22.61	21.42	389.77	390.40	22	20	13.78	12.64
FEB	74.04	74.53	14	15	4.02	4.36	67.25	67.41	16	17	2.83	2.76
FAB	64.25	63.68	14	15	4.02	3.74	57.27	57.77	16	17	2.67	2.74
FHD	41.38	41.19	16	15	2.66	2.81	37.12	37.31	22	22	1.53	1.47
FMLD	24.92	24.03	16	15	1.84	1.34	22.54	22.36	22	22	0.89	1.15
FAPD	25.97	25.68	16	15	2.28	2.13	24.34	24.33	22	22	1.65	1.34
TML	352.44	353.29	17	17	22.39	22.55	328.25	328.14	22	22	11.50	10.90
TFL	348.44	349.11	17	17	22.06	22.20	324.64	324.77	22	22	11.69	10.86
TPB	66.73	68.58	15	13	3.31	3.09	62.54	62.44	13	16	2.18	3.12
TPAB	65.74	66.82	15	14	3.10	3.14	60.12	60.77	17	18	2.29	2.90
TMLD	21.31	22.72	17	17	1.52	1.53	19.64	20.23	22	22	1.00	1.34
TAPD	26.88	26.16	17	17	2.24	2.44	23.68	23.50	22	22	1.62	1.59
FIML	341.15	338.68	13	14	17.10	16.76	317.43	318.68	14	20	10.65	10.83
BIB	264.82		17		16.57		252.13		23		10.55	
IBL	142.54	143.63	13	16	7.70	7.80	134.24	136.00	17	20	5.06	4.63
ACH	46.23	46.65	15	16	2.55	2.51	42.41	42.33	22	23	1.64	1.56
TCH	62.00	65.00	10	7	4.68	4.90	56.73	58.13	11	15	2.61	3.16
TTB	26.52	26.58	9	7	1.70	1.48	24.75	24.86	12	15	1.29	1.69

FORT ANCIENT

Dimension	MALES						FEMALES					
	Mean		n	Std. Dev.		Mean		n	Std. Dev.			
	left	right		left	right	left	right		left	right		
BBH	140.43		14	5.17		138.50		4	3.11			
GBL	175.92		13	7.47		163.60		5	10.62			
EUB	137.92		13	5.92		138.20		5	5.50			
UFH	83.81		11	3.99		79.60		3	6.15			
NAH	27.47		10	3.14		27.47		4	4.18			
NAW	24.65		12	2.34		22.89		5	2.23			
ZYG	139.08		12	6.02		131.25		4	4.86			
JNB	26.44		12	2.37		22.87		4	0.55			
CML	160.58	158.64	12	14	6.54	9.15	140.33	136.33	6	6	4.29	5.57
CAPD	12.10	12.45	13	14	0.91	1.34	10.27	10.79	7	6	0.58	0.59
CSID	9.82	10.35	13	14	1.33	0.94	8.88	8.88	7	6	0.57	1.27
C1	11.95		10	1.37		11.09		7	1.33			
XC2	37.92		14	2.41		35.59		6	2.47			
XC3	13.96		14	1.02		11.93		6	0.62			
XC4	13.25		15	0.96		12.01		6	0.94			
XC5	13.20		15	1.29		12.07		6	1.14			
XC6	13.71		14	0.86		11.99		7	1.11			
XC7	15.17		14	0.75		13.39		7	1.05			
XT1	17.15		14	0.75		15.64		7	0.92			
XT2	18.61		15	0.91		17.28		7	0.91			
XT3	18.61		14	0.76		16.97		7	0.96			
XT4	19.30		14	0.72		17.39		7	0.76			
XT5	19.73		15	0.72		17.92		6	1.39			
XT6	20.72		15	0.80		18.54		5	0.88			
XT7	21.22		14	0.80		19.32		6	1.19			
XT8	21.57		14	0.84		19.61		7	0.79			
XT9	22.30		14	1.05		20.56		7	0.94			
XT10	22.87		14	1.17		21.88		7	1.15			
XT11	23.93		14	1.10		22.66		7	1.41			
XT12	25.50		14	1.66		24.98		7	1.56			
XL1	27.23		14	1.60		26.17		7	1.24			
XL2	27.69		14	1.47		27.31		7	1.23			
XL3	28.38		14	1.62		28.39		7	1.84			
XL4	29.68		14	1.42		29.23		7	1.43			

FORT ANCIENT, CONTINUED

Dimension	MALES						FEMALES					
	Mean		n		Std. Dev.		Mean		n		Std. Dev.	
	left	right			left	right	left	right			left	right
XL5	30.09		14		1.28		29.76		7		1.73	
S1	32.80		14		2.35		31.88		7		2.62	
SML	116.59		8		4.91		100.89		3		13.47	
HML	326.79	325.43	12	15	9.25	7.41	298.43	302.75	7	8	11.90	9.87
HEB	60.50	61.03	12	15	1.58	2.26	53.57	55.57	7	7	2.34	2.11
HHD	46.16	46.04	13	15	2.01	1.79	40.26	40.50	7	8	2.15	1.67
HMLD	21.60	21.88	12	15	0.97	1.32	18.87	19.66	7	8	1.19	1.32
HAPD	20.04	21.81	12	15	1.09	1.54	18.64	20.35	7	8	1.93	1.16
HAB	42.77	42.85	12	15	1.45	1.66	38.58	39.12	8	7	1.79	1.89
RML	254.03	254.96	12	14	8.24	9.77	227.00	232.33	4	6	10.86	9.14
RMLD	14.55	15.20	12	14	0.66	3.38	14.44	15.09	4	6	1.48	1.12
RAPD	12.20	12.33	12	14	0.70	0.73	10.74	11.48	4	6	0.76	0.59
RMLH	21.15	21.92	13	13	1.28	.80	19.39	20.19	3	6	1.59	1.03
RAPH	22.26	22.68	13	13	1.47	1.10	20.72	20.43	2	6	1.73	1.00
RAB	25.73	25.06	12	12	1.49	1.41	23.58	23.65	6	7	1.78	1.38
UML	270.41	272.23	11	13	5.82	8.58	244.83	251.00	6	6	14.56	10.37
UMLD	13.39	13.33	11	13	1.34	1.01	11.73	12.42	6	6	1.04	1.24
UAPD	16.05	15.15	11	13	1.45	1.40	14.42	15.25	6	6	1.01	0.76
FML	453.43	452.68	14	14	14.70	13.59	421.00	421.14	8	7	14.07	8.07
FBL	450.36	448.96	14	14	13.51	13.12	416.31	417.29	8	7	13.16	7.25
FEB	83.36	83.35	14	13	3.05	2.98	73.13	73.10	8	5	1.64	2.22
FAB	72.88	72.71	14	13	2.41	2.05	64.46	63.58	8	6	2.15	1.67
FHD	46.73	47.47	14	14	2.93	2.60	41.45	41.55	8	8	1.79	1.54
FMLD	26.37	26.17	14	14	1.85	1.95	24.84	23.67	7	7	1.43	1.46
FAPD	29.79	29.66	14	14	1.95	2.01	26.59	26.16	8	7	2.17	1.88
TML	381.71	380.46	14	14	11.04	10.31	345.14	346.00	7	8	12.17	12.20
TFL	377.11	376.29	14	14	12.01	10.34	341.07	342.81	7	8	12.50	12.84
TPB	76.83	75.96	15	14	3.10	3.27	67.93	67.31	7	8	2.85	2.37
TPAB	75.13	74.78	15	14	2.61	3.13	66.23	66.25	7	8	2.62	2.21
TMLD	23.46	24.16	14	14	2.00	3.78	20.87	21.18	7	8	1.14	1.82
TAPD	31.05	30.48	14	14	2.95	3.44	25.71	26.28	7	8	1.98	1.94
FIML	368.00	362.25	9	8	13.43	8.72	337.10	331.75	5	2	7.35	2.47
BIB	270.10		15		10.53		264.58		6		7.95	
IBL	156.08	155.09	12	11	4.21	4.89	146.83	148.50	6	6	6.27	7.37
ACH	51.70	51.93	15	14	2.71	2.28	47.67	46.72	7	6	1.80	1.87
TCH	68.12	69.32	13	14	3.36	3.13	60.58	61.50	6	4	3.14	4.20
TTB	30.95	30.79	13	15	1.29	1.34	27.66	27.58	6	5	1.28	1.13

LIBBEN

Dimension	MALES						FEMALES					
	Mean		n	Std. Dev.		Mean		n	Std. Dev.			
	left	right		left	right	left	right		left	right		
BBH	145.64		14	7.72		136.92		13	6.10			
GBL	186.14		14	8.65		178.14		14	5.86			
EUB	139.14		14	4.49		135.43		14	3.98			
UFH	84.36		14	4.15		77.04		15	5.43			
NAH	32.03		13	2.45		28.65		10	1.55			
NAW	26.32		17	1.69		25.33		16	1.75			
ZYG	140.21		14	5.60		132.50		14	6.37			
JNB	30.03		19	3.17		25.66		14	2.23			
CML	158.71	156.65	22	23	7.07	8.55	144.00	141.32	19	20	5.55	5.14
CAPD	11.11	11.53	22	23	1.18	1.42	9.89	10.17	19	20	0.88	0.73
CSID	9.44	9.63	22	23	0.92	0.80	8.72	8.90	19	20	0.70	0.66
C1	11.24		13	1.03		10.39		14	1.30			
XC2	37.86		17	1.67		34.52		19	3.07			
XC3	12.90		17	0.95		11.70		19	1.12			
XC4	12.70		18	0.95		11.41		18	0.97			
XC5	12.48		20	1.16		11.52		18	0.89			
XC6	12.81		22	0.91		11.89		21	1.03			
XC7	14.49		22	0.67		13.42		21	1.02			
XT1	16.44		21	0.83		15.31		22	1.23			
XT2	17.99		21	0.78		16.63		22	0.78			
XT3	18.06		21	0.83		16.99		23	0.77			
XT4	18.56		21	0.78		17.27		22	0.88			
XT5	19.18		21	0.83		17.80		22	1.01			
XT6	20.03		21	0.71		18.37		22	0.93			
XT7	20.77		21	0.94		18.95		21	0.70			
XT8	21.18		22	0.98		19.69		22	1.10			
XT9	22.00		22	1.15		20.23		22	0.97			
XT10	22.67		22	1.29		20.81		22	0.99			
XT11	23.07		22	1.08		21.54		23	1.18			
XT12	24.94		22	1.23		23.52		23	1.33			
XL1	26.23		24	1.54		25.14		26	1.23			
XL2	26.79		19	1.47		25.37		25	1.18			
XL3	27.82		18	1.72		26.40		25	1.33			
XL4	29.09		18	1.81		27.02		25	1.38			

LIBBEN, CONTINUED

Dimension	MALES						FEMALES					
	Mean		<i>n</i>		Std. Dev.		Mean		<i>n</i>		Std. Dev.	
	left	right			left	right	left	right			left	right
XL5	29.69		19		2.27		27.65		25		1.55	
S1	31.17		19		1.67		29.83		24		1.72	
SML	115.30		15		8.45		108.56		18		9.05	
HML	332.17	334.88	18	16	9.56	10.44	308.50	309.66	20	19	9.72	11.04
HEB	61.00	60.97	17	18	3.34	2.74	55.10	55.18	20	22	2.28	2.67
HHD	45.51	45.74	18	16	2.13	1.69	40.45	40.30	19	22	1.82	1.89
HMLD	20.96	21.47	18	17	1.19	1.61	19.36	19.65	20	20	1.31	1.26
HAPD	19.92	20.72	18	17	1.13	1.71	18.94	19.48	20	20	1.07	1.41
HAB	43.63	43.78	18	17	1.95	1.66	39.17	38.99	20	22	1.88	1.92
RML	265.60	269.25	21	18	12.94	11.65	241.97	243.65	19	20	10.81	10.78
RMLD	13.79	14.03	22	18	1.35	1.37	13.50	13.59	19	20	1.12	0.81
RAPD	11.88	12.04	22	18	0.83	0.78	10.50	10.53	19	20	0.60	0.69
RMLH	21.81	22.38	21	18	1.03	0.95	19.74	19.86	19	19	0.91	0.90
RAPH	22.59	22.90	21	18	1.10	0.83	20.42	20.21	19	19	1.03	0.89
RAB	25.43	25.70	22	18	1.54	1.45	23.41	24.12	19	20	1.03	1.14
UML	289.38	287.94	16	16	14.58	11.45	261.29	263.15	17	24	10.86	10.47
UMLD	12.35	12.70	16	16	0.99	1.06	11.16	11.26	17	24	0.83	0.64
UAPD	14.83	14.79	16	16	1.68	1.51	13.76	14.02	17	24	0.92	1.37
FML	460.28	463.65	18	17	16.81	15.72	429.23	427.97	13	18	12.76	14.05
FBL	455.32	460.00	17	17	15.21	15.17	424.54	423.88	12	16	12.69	14.86
FEB	80.24	80.41	21	17	2.91	2.94	72.73	73.00	15	19	3.20	3.30
FAB	70.78	70.75	21	17	2.76	2.88	64.29	63.99	15	20	3.42	3.53
FHD	45.82	46.02	18	19	1.68	1.27	41.01	40.98	17	17	2.15	2.02
FMLD	25.77	25.73	20	17	1.83	1.96	24.89	24.11	15	17	1.58	0.99
FAPD	27.75	27.61	20	17	1.82	1.99	25.83	25.98	15	17	1.66	1.33
TML	394.50	391.71	16	22	16.10	15.11	356.31	358.07	21	22	10.64	10.57
TFL	391.75	389.02	16	22	15.99	14.97	352.95	354.71	21	22	10.13	10.45
TPB	75.68	75.81	17	21	2.55	2.37	70.02	69.36	21	22	3.18	3.45
TPAB	73.24	74.03	18	22	2.81	2.70	67.20	67.39	20	22	2.91	3.37
TMLD	20.69	22.46	16	22	1.92	1.71	19.33	20.91	21	21	0.99	1.35
TAPD	28.44	27.58	16	22	2.08	1.49	24.77	24.88	21	21	1.73	1.71
FIML	379.25	375.39	12	14	16.43	14.99	343.17	341.32	18	17	10.11	9.52
BIB	271.91		16		17.54		264.56		16		12.23	
IBL	154.79	154.78	14	9	6.87	6.94	147.27	143.63	15	8	7.94	5.90
ACH	50.93	51.00	14	9	1.87	1.60	46.67	45.40	17	10	2.05	1.64
TCH	66.83	67.38	12	8	2.39	2.15	60.56	60.16	18	16	2.61	2.71
TTB	31.16	30.49	11	10	1.65	0.93	28.35	28.38	20	19	1.73	1.78

MADISONVILLE

Dimension	MALES						FEMALES					
	Mean		n	Std. Dev.		Mean		n	Std. Dev.			
	left	right		left	right	left	right		left	right		
BBH	137.92		13	4.13		135.00		10	4.55			
GBL	174.33		12	3.58		168.90		10	7.17			
EUB	147.75		12	6.82		145.20		10	5.45			
UFH	80.61		11	3.45		77.08		10	5.45			
NAH	27.82		10	1.52		27.25		8	1.98			
NAW	25.17		11	1.13		25.47		11	1.23			
ZYG	144.27		11	5.82		137.64		11	4.41			
JNB	22.92		14	2.91		23.70		13	3.44			
CML	154.94	154.00	16	17	6.12	6.75	142.50	139.22	16	18	7.74	7.38
CAPD	11.55	11.93	16	17	0.90	1.14	10.13	10.30	16	18	0.83	0.99
CSID	9.75	9.97	16	17	1.05	.96	9.04	9.53	16	18	1.06	1.14
C1	12.39		16	1.08		10.83		14	1.18			
XC2	37.72		16	1.52		34.93		13	2.44			
XC3	13.66		16	1.07		12.51		13	1.25			
XC4	13.12		14	0.90		12.32		12	0.92			
XC5	12.86		14	0.94		11.76		15	1.13			
XC6	13.26		16	1.01		12.25		15	0.86			
XC7	14.85		16	0.93		14.09		14	0.87			
XT1	16.70		16	0.87		15.58		15	0.94			
XT2	18.37		16	1.06		17.30		16	0.84			
XT3	17.99		16	1.01		17.40		16	0.84			
XT4	18.80		16	1.10		18.06		16	0.85			
XT5	19.31		16	0.71		18.53		16	0.93			
XT6	20.03		16	0.94		19.29		16	0.84			
XT7	20.59		16	0.80		19.67		17	1.17			
XT8	21.12		16	0.89		20.12		17	1.04			
XT9	21.89		16	0.97		20.83		16	1.04			
XT10	22.69		16	1.06		21.28		16	0.80			
XT11	23.22		16	1.10		22.10		16	0.85			
XT12	25.27		16	1.43		24.36		16	1.27			
XL1	26.51		16	1.27		25.59		17	1.19			
XL2	26.97		16	1.16		26.37		17	2.03			
XL3	28.13		16	1.62		27.12		17	1.77			
XL4	28.98		16	1.50		27.97		17	1.57			

MADISONVILLE, CONTINUED

Dimension	MALES						FEMALES					
	Mean		n		Std. Dev.		Mean		n		Std. Dev.	
	left	right			left	right	left	right			left	right
XL5	29.49		16		1.51		27.98		17		1.88	
S1	32.34		15		2.24		30.58		19		2.07	
SML	117.27		6		7.03		113.00		13		8.42	
HML	313.92	315.87	18	19	14.75	14.01	296.13	300.13	19	20	14.28	13.19
HEB	58.50	59.50	18	16	2.60	2.85	54.58	55.13	19	20	2.26	2.86
HHD	44.28	44.99	18	19	2.80	2.97	41.02	41.09	19	20	2.38	2.27
HMLD	21.70	21.88	18	19	1.59	1.47	19.08	19.29	19	20	1.12	1.23
HAPD	19.73	20.62	18	19	1.70	1.66	18.83	19.11	19	20	1.22	1.12
HAB	42.24	43.23	18	17	1.75	1.61	39.51	39.71	19	19	2.11	1.97
RML	246.00	249.16	17	16	11.57	12.42	230.28	233.37	18	19	13.15	13.45
RMLD	14.28	14.46	17	16	1.49	1.46	13.88	14.06	18	19	1.44	1.01
RAPD	11.96	11.96	17	16	0.90	0.98	10.74	10.58	18	19	0.57	0.61
RMLH	21.18	21.38	16	16	1.00	1.21	19.40	19.41	18	19	1.02	1.02
RAPH	22.12	22.52	16	15	0.93	1.03	20.16	20.23	18	19	1.08	1.06
RAB	24.63	25.27	17	18	1.38	1.51	23.84	23.84	18	18	1.41	1.66
UML	264.12	271.50	13	15	13.22	11.11	251.42	251.42	12	18	13.55	13.42
UMLD	12.78	13.65	13	15	0.87	1.15	12.19	12.32	12	18	0.82	1.21
UAPD	14.56	14.83	13	15	1.92	1.61	13.90	14.09	12	18	0.75	1.32
FML	447.81	446.33	18	18	25.16	24.99	425.84	424.30	19	20	20.64	22.32
FBL	443.50	440.50	19	17	23.66	23.99	419.71	417.30	19	20	20.09	21.63
FEB	79.61	78.94	18	16	3.45	3.17	74.68	74.70	19	20	3.61	3.53
FAB	70.17	70.01	18	16	3.69	3.77	65.37	65.65	19	20	3.01	2.82
FHD	46.04	46.15	19	18	2.17	2.18	42.47	43.29	20	20	2.17	2.14
FMLD	26.65	26.57	19	18	2.43	2.09	25.62	23.47	19	20	2.15	2.08
FAPD	28.73	28.32	19	18	2.83	2.10	25.91	25.77	19	20	1.89	1.43
TML	375.58	370.53	19	17	23.49	17.51	350.05	350.90	19	20	17.71	17.18
TFL	371.26	366.21	19	17	22.81	16.65	345.22	346.93	19	20	17.06	16.66
TPB	74.79	74.53	19	17	3.22	3.29	69.42	69.38	18	20	3.25	3.28
TPAB	72.81	72.45	19	17	2.97	3.00	67.19	67.91	18	20	2.92	3.10
TMLD	22.32	23.41	18	17	1.89	2.20	20.14	20.81	18	20	1.37	1.19
TAPD	29.47	28.93	18	17	2.18	2.23	24.82	24.82	18	20	1.87	1.34
FIML	353.57	357.09	7	11	21.19	16.64	339.50	337.28	6	9	13.87	17.51
BIB	273.03		15		15.82		262.87		19		9.84	
IBL	154.43	156.23	14	13	7.87	8.05	149.00	147.94	16	16	7.62	5.23
ACH	51.51	51.15	19	17	2.56	3.01	47.97	47.93	18	16	2.30	2.25
TCH	65.12	66.73	13	13	3.26	3.67	61.77	62.73	13	15	3.73	3.37
TTB	29.82	29.96	14	14	2.04	2.13	28.32	28.10	13	15	1.77	1.38

MOBRIDGE

Dimension	MALES						FEMALES					
	Mean		n	Std. Dev.		Mean		n	Std. Dev.			
	left	right		left	right	left	right		left	right		
BBH	133.56		18	3.52		127.46		13	4.29			
GBL	176.11		18	6.69		167.54		13	8.10			
EUB	141.39		18	4.92		137.31		13	3.25			
UFH	83.24		18	4.30		79.21		13	4.42			
NAH	32.56		18	2.88		28.34		12	2.73			
NAW	26.27		18	1.96		24.86		13	2.00			
ZYG	140.33		18	6.19		129.92		13	4.79			
JNB	23.03		18	3.64		22.69		11	3.53			
CML	158.97	158.33	16	21	7.99	11.92	140.04	138.73	14	13	7.79	7.44
CAPD	10.83	11.78	16	20	0.79	1.04	9.58	10.03	14	13	0.86	0.98
CSID	10.70	10.43	16	20	1.29	1.36	8.61	8.71	14	13	1.03	0.98
C1	11.72		21	1.20		10.63		13	1.17			
XC2	38.56		21	2.49		35.20		14	2.32			
XC3	13.68		21	1.25		14.05		14	5.49			
XC4	13.58		20	0.94		12.39		12	0.71			
XC5	13.56		19	1.16		12.05		13	1.10			
XC6	13.75		20	0.93		12.27		13	0.93			
XC7	15.07		20	0.92		13.87		13	0.83			
XT1	17.07		21	0.97		15.78		14	1.15			
XT2	18.60		21	1.01		16.99		14	1.23			
XT3	18.40		19	0.82		17.00		13	1.12			
XT4	18.74		20	1.02		17.55		13	0.93			
XT5	19.20		22	1.15		18.12		13	0.87			
XT6	20.05		21	1.07		18.59		12	1.18			
XT7	20.92		21	1.11		19.12		12	1.09			
XT8	21.54		22	1.26		19.75		12	1.13			
XT9	22.42		21	0.79		20.30		12	1.16			
XT10	22.89		20	1.35		20.83		12	1.36			
XT11	23.62		20	1.00		21.93		12	1.29			
XT12	25.13		20	1.19		24.32		12	1.18			
XL1	26.57		21	0.90		25.49		12	1.11			
XL2	26.62		22	1.20		26.16		12	0.85			
XL3	27.27		22	1.33		27.14		12	1.32			
XL4	28.17		22	1.36		27.63		13	1.46			

MOBRIDGE, CONTINUED

Dimension	MALES						FEMALES					
	Mean		n		Std. Dev.		Mean		n		Std. Dev.	
	left	right			left	right	left	right			left	right
XL5	28.62		22		1.13		27.86		13		1.56	
S1	31.93		23		2.01		29.37		14		2.81	
SML	111.02		19		6.85		109.15		8		7.84	
HML	320.00	324.60	23	20	13.76	11.97	290.89	300.12	14	13	14.79	14.81
HEB	60.70	62.05	23	22	3.05	2.64	54.77	55.31	11	13	3.91	3.33
HHD	46.62	47.52	22	22	1.86	1.99	40.52	41.26	14	11	2.26	1.94
HMLD	21.42	21.54	23	20	1.34	1.44	19.66	19.80	14	14	1.72	1.88
HAPD	19.45	21.46	23	20	1.61	1.72	19.57	20.33	14	14	1.16	1.50
HAB	42.35	42.08	22	22	2.10	2.09	38.84	38.09	10	13	1.94	1.42
RML	250.24	254.68	23	22	14.03	9.41	229.79	234.77	12	13	8.85	6.20
RMLD	14.14	14.64	23	23	1.11	1.11	13.78	14.25	12	13	0.97	1.20
RAPD	11.82	12.09	23	23	0.91	0.88	10.75	10.80	12	13	0.61	0.61
RMLH	21.31	21.87	22	23	1.06	1.10	19.50	19.85	10	13	1.39	1.12
RAPH	22.35	22.84	23	21	1.41	1.41	20.23	20.69	10	13	1.35	1.07
RAB	26.33	27.16	22	23	1.48	1.26	25.05	25.16	13	13	1.59	1.17
UML	268.63	273.63	20	24	14.36	10.18	248.58	252.23	12	13	8.43	7.77
UMLD	12.71	13.25	20	25	0.75	0.90	11.80	12.58	12	13	1.07	1.24
UAPD	14.92	15.59	20	25	1.50	1.30	14.07	14.49	12	13	2.04	1.76
FML	446.15	447.00	24	22	26.44	25.23	409.64	408.00	14	13	16.74	15.33
FBL	443.87	444.64	23	22	26.65	24.88	405.46	405.08	14	12	15.79	14.99
FEB	82.09	83.48	23	23	4.84	4.56	74.07	73.91	14	11	3.59	3.78
FAB	72.33	72.97	23	23	4.05	4.04	64.73	64.12	14	12	3.04	2.91
FHD	46.23	46.91	25	22	3.02	2.99	41.54	41.65	14	14	2.94	2.85
FMLD	27.25	26.86	24	23	1.71	1.76	24.66	23.71	14	13	1.40	1.51
FAPD	29.94	30.59	24	23	2.67	2.56	26.36	26.23	14	13	1.42	1.86
TML	379.36	382.48	25	21	22.75	19.54	352.17	349.39	12	13	13.55	13.23
TFL	375.61	379.36	25	21	22.48	19.88	348.04	346.50	12	13	13.80	13.60
TPB	77.03	77.22	19	20	4.74	4.81	68.00	67.89	13	14	3.52	3.65
TPAB	74.27	75.32	19	20	4.41	4.61	66.53	66.50	13	14	3.26	3.15
TMLD	23.23	24.56	25	20	1.80	1.94	21.09	21.38	12	13	1.80	1.19
TAPD	31.28	30.85	25	20	2.87	3.09	25.54	25.00	12	13	1.71	2.41
FIML	361.00	368.95	21	21	33.61	20.16	339.31	341.62	13	13	11.43	12.65
BIB	281.83		21		16.41		271.83		12		19.55	
IBL	164.93	161.77	14	13	9.50	7.88	151.33	151.18	9	11	9.85	8.29
ACH	52.14	52.68	22	21	3.25	2.36	47.66	47.11	12	11	2.94	3.53
TCH	68.55	67.81	21	18	5.93	5.86	60.88	61.25	12	14	5.17	5.03
TTB	29.34	29.31	20	19	1.61	1.88	26.41	26.99	9	12	2.01	1.94

LARSON

Dimension	MALES						FEMALES					
	Mean		<i>n</i>	Std. Dev.		Mean		<i>n</i>	Std. Dev.			
	left	right		left	right	left	right		left	right		
BBH	134.79		14	4.14		126.07		14	5.54			
GBL	179.29		14	4.38		172.57		14	5.69			
EUB	137.57		14	3.25		134.93		14	3.73			
UFH	83.84		14	2.79		80.43		14	3.14			
NAH	31.93		14	1.52		28.97		13	1.85			
NAW	25.22		14	1.55		25.10		14	1.80			
ZYG	138.93		14	3.79		127.71		14	3.41			
JNB	30.27		13	3.13		26.28		12	2.99			
CML	160.09	160.46	16	12	7.66	6.60	139.60	137.90	15	15	8.48	7.50
CAPD	11.21	11.82	16	12	1.45	1.29	9.60	10.06	15	16	1.01	0.94
CSID	9.94	10.00	16	12	1.08	1.05	8.44	8.95	15	16	0.89	1.35
C1	11.90		13	2.08		10.79		15	1.39			
XC2	38.18		14	1.83		34.83		15	2.15			
XC3	13.91		14	0.62		12.04		15	0.84			
XC4	13.48		12	0.93		12.04		14	0.95			
XC5	12.91		13	0.93		11.59		14	0.80			
XC6	13.41		14	0.56		11.92		14	0.86			
XC7	14.83		14	0.60		13.63		14	0.93			
XT1	16.85		14	0.60		15.41		16	0.88			
XT2	18.38		15	0.63		16.75		16	0.95			
XT3	18.28		15	0.69		16.99		16	1.00			
XT4	18.40		15	0.81		17.13		15	1.00			
XT5	19.10		15	1.13		17.81		15	1.05			
XT6	20.20		15	0.97		18.51		16	1.02			
XT7	20.75		14	0.89		18.92		16	0.93			
XT8	21.46		14	1.26		19.62		16	1.14			
XT9	22.19		14	0.90		20.27		15	0.72			
XT10	22.90		13	1.20		20.73		15	0.80			
XT11	23.15		14	1.11		21.46		16	1.02			
XT12	25.08		14	1.20		22.83		16	1.63			
XL1	26.03		14	1.14		25.12		16	1.38			
XL2	26.80		14	1.50		26.22		16	1.38			
XL3	27.46		15	1.26		26.88		16	1.65			
XL4	28.61		16	1.40		27.58		16	1.85			

LARSON, CONTINUED

Dimension	MALES						FEMALES					
	Mean		n		Std. Dev.		Mean		n		Std. Dev.	
	left	right			left	right	left	right			left	right
XL5	28.90		16		1.90		28.46		16		1.94	
S1	31.67		14		2.19		29.65		16		2.20	
SML	110.18		12		8.32		106.60		15		10.57	
HML	315.92	319.21	13	14	10.65	12.01	293.11	298.53	15	14	10.55	10.20
HEB	60.33	61.21	12	14	2.71	3.00	54.80	56.00	14	15	3.30	3.28
HHD	45.90	46.44	13	14	1.98	3.08	40.66	40.54	14	14	1.84	1.81
HMLD	21.03	21.31	13	14	1.56	1.83	18.52	18.89	16	14	1.63	1.21
HAPD	19.53	21.08	13	14	1.45	1.50	18.71	19.45	16	14	1.65	1.93
HAB	43.60	43.30	12	14	1.74	2.29	39.92	39.67	15	14	2.16	2.36
RML	252.50	252.17	13	15	12.50	11.70	231.40	233.22	16	15	12.53	11.71
RMLD	14.19	14.40	13	14	1.43	1.24	13.50	13.95	16	15	1.40	1.34
RAPD	12.03	12.26	13	14	0.64	0.52	10.80	10.88	16	15	0.83	0.89
RMLH	21.54	21.96	13	14	1.19	1.15	19.36	20.18	15	14	0.78	1.03
RAPH	22.75	22.73	13	14	1.30	0.99	20.20	20.67	15	14	0.87	1.07
RAB	26.05	26.12	13	15	1.57	1.40	24.10	24.76	16	15	1.42	1.48
UML	270.15	269.75	13	14	13.54	12.17	251.37	252.66	16	15	13.55	12.42
UMLD	12.42	12.61	13	14	0.72	0.79	11.44	11.34	16	15	1.29	0.89
UAPD	15.83	15.56	13	14	1.69	1.25	14.57	14.64	16	15	1.40	1.83
FML	445.30	443.63	15	15	16.27	15.48	417.03	414.06	16	15	20.76	18.60
FBL	442.14	440.37	14	15	16.27	14.96	411.93	409.63	16	15	20.10	18.60
FEB	83.04	82.68	13	14	3.48	3.49	74.92	75.29	14	13	4.77	3.12
FAB	74.43	74.18	14	15	3.79	3.42	66.67	65.99	14	14	4.29	3.09
FHD	45.45	45.70	15	15	2.21	1.60	41.44	41.70	16	16	1.97	2.04
FMLD	27.21	27.01	16	15	1.64	1.64	24.46	24.02	16	16	1.39	1.43
FAPD	30.22	30.07	16	15	2.39	2.21	25.78	25.69	16	16	1.71	2.01
TML	380.07	381.73	14	15	17.98	17.27	352.56	351.97	15	16	21.18	21.83
TFL	376.36	378.70	14	15	17.60	17.40	348.70	348.30	15	16	20.56	21.74
TPB	78.69	79.40	13	15	2.17	2.16	70.43	70.21	14	14	3.75	3.07
TPAB	77.14	77.06	14	16	2.21	3.20	68.98	68.59	14	14	3.26	2.96
TMLD	24.17	24.62	15	15	1.75	1.35	20.86	21.43	15	16	1.45	1.42
TAPD	29.84	30.03	15	15	1.85	1.68	25.60	25.27	15	16	1.24	1.49
FIML	369.04	370.29	12	14	17.82	16.03	342.11	341.27	15	14	21.45	21.74
BIB	281.23		13		12.54		269.75		16		13.58	
IBL	159.50	161.42	10	12	6.62	5.98	150.87	151.07	15	15	5.89	6.31
ACH	51.31	51.30	11	13	1.41	1.79	47.62	47.85	16	16	2.30	2.03
TCH	66.07	66.88	14	13	2.00	2.78	60.94	60.69	16	16	3.55	3.93
TTB	31.54	31.74	14	14	1.68	1.64	28.74	28.89	16	16	2.15	2.02

CHEYNNE RIVER SITES

Dimension	MALES						FEMALES					
	Mean		<i>n</i>	Std. Dev.		Mean		<i>n</i>	Std. Dev.			
	left	right		left	right	left	right		left	right		
BBH	130.70		10	4.76		129.80		5	3.27			
GBL	172.10		10	5.28		170.40		5	5.13			
EUB	136.50		10	4.81		134.00		5	1.87			
UFH	82.81		10	4.91		78.74		5	4.22			
NAH	33.52		10	2.72		30.58		5	3.19			
NAW	25.21		10	2.33		24.48		5	2.02			
ZYG	136.78		9	3.90		126.00		5	2.24			
JNB	20.88		14	3.08		19.85		9	3.88			
CML	156.64	156.54	14	13	5.89	6.62	141.64	139.21	7	7	5.73	6.34
CAPD	10.82	11.28	14	13	0.73	1.22	9.74	9.58	7	7	0.65	0.58
CSID	9.35	9.93	14	13	0.78	1.13	8.11	8.54	7	7	1.02	1.16
C1	10.84		15	1.12		10.27		10	0.72			
XC2	37.22		13	2.27		34.13		9	2.41			
XC3	13.21		13	1.14		11.80		9	1.21			
XC4	13.45		10	0.62		12.10		8	0.93			
XC5	13.01		10	0.74		11.80		8	0.94			
XC6	13.65		10	0.76		12.04		9	0.93			
XC7	14.88		10	1.05		13.25		8	0.71			
XT1	16.77		15	1.23		15.01		8	1.04			
XT2	17.78		14	1.01		16.22		9	1.38			
XT3	17.51		13	1.25		16.41		8	1.06			
XT4	17.98		13	1.27		16.88		8	0.97			
XT5	18.54		14	1.10		17.75		9	1.07			
XT6	19.26		14	1.07		18.50		9	1.12			
XT7	20.32		14	1.27		19.11		9	0.98			
XT8	21.13		14	1.34		19.64		9	0.90			
XT9	21.93		14	1.54		19.97		9	0.89			
XT10	22.48		14	1.30		20.73		9	1.03			
XT11	22.94		15	1.33		21.77		10	1.18			
XT12	24.65		15	1.27		23.18		8	0.70			
XL1	26.56		14	1.21		24.83		8	0.79			
XL2	26.85		13	0.99		26.04		9	0.87			
XL3	27.35		15	0.81		26.99		10	1.08			
XL4	28.12		15	0.93		27.52		9	1.75			

CHEYENNE RIVER SITES, CONTINUED

Dimension	MALES						FEMALES					
	Mean		<i>n</i>		Std. Dev.		Mean		<i>n</i>		Std. Dev.	
	left	right			left	right	left	right			left	right
XL5	28.78		15		1.37		28.02		9		1.91	
S1	30.35		15		1.35		28.91		10		2.86	
SML	108.62		13		9.44		107.49		9		15.09	
HML	316.46	314.39	13	13	10.72	25.59	292.33	299.45	9	10	11.72	11.08
HEB	58.38	59.62	13	13	2.49	3.37	53.11	53.78	9	9	2.72	3.19
HHD	45.28	46.14	14	13	2.45	2.40	39.84	39.60	9	8	1.48	1.35
HMLD	20.51	20.41	13	13	1.24	1.45	18.42	18.57	9	10	0.94	1.23
HAPD	18.55	20.46	13	13	1.09	1.31	18.41	19.62	9	10	1.12	0.76
HAB	39.89	40.14	13	13	1.90	2.09	36.86	35.69	10	9	2.28	2.22
RML	252.65	254.89	13	14	7.28	7.56	228.94	231.31	8	8	7.05	7.84
RMLD	13.53	13.79	13	14	0.94	0.89	12.91	13.01	8	8	0.94	0.92
RAPD	11.14	11.48	13	14	0.59	0.75	10.35	10.53	8	8	0.55	0.50
RMLH	20.94	21.57	14	13	0.81	0.78	18.89	19.13	8	9	0.83	1.45
RAPH	22.27	22.39	14	14	0.93	1.07	19.72	19.79	7	9	0.86	1.18
RAB	25.55	26.65	13	14	1.35	1.76	23.28	23.79	8	9	1.05	1.15
UML	269.65	274.25	13	14	7.85	7.54	249.07	251.72	7	9	7.67	8.48
UMLD	12.00	12.87	13	14	0.71	0.82	11.74	11.59	7	9	1.12	0.84
UAPD	13.94	15.04	13	14	1.41	1.11	14.05	15.04	7	9	1.65	1.02
FML	451.93	447.86	14	14	13.94	13.86	417.86	416.05	11	10	12.03	13.55
FBL	447.57	444.25	14	14	13.97	13.81	414.27	408.50	11	9	18.49	12.51
FEB	82.14	81.89	14	14	3.36	2.98	73.80	72.56	10	9	2.06	2.54
FAB	72.67	71.78	14	13	3.32	2.27	63.97	63.60	10	9	2.01	2.40
FHD	45.63	45.46	14	14	1.96	2.43	41.85	41.85	11	11	2.39	2.07
FMLD	26.65	26.03	14	14	1.03	1.09	24.71	23.92	11	10	1.51	1.67
FAPD	29.33	29.90	14	14	1.98	1.66	26.40	25.94	11	10	1.45	1.59
TML	382.60	383.73	15	13	12.29	11.85	348.25	350.05	10	11	12.56	14.61
TFL	378.40	380.14	15	13	12.14	11.31	344.65	347.68	10	11	13.00	14.94
TPB	76.54	76.42	14	12	3.42	3.01	68.83	67.69	9	8	2.35	2.53
TPAB	74.69	74.95	14	12	3.18	3.18	66.86	66.10	9	8	1.82	2.34
TMLD	23.27	24.06	15	13	1.81	1.47	21.12	21.66	10	11	1.50	1.34
TAPD	29.92	29.69	15	13	2.93	2.21	24.36	24.92	10	11	1.46	1.74
FIML	371.12	372.63	13	15	13.62	12.64	337.22	342.20	9	10	14.37	15.16
BIB	277.60		15		10.12							
IBL	160.11	159.83	9	12	6.53	5.41	150.20	149.00	10	9	4.83	6.54
ACH	50.52	50.33	15	15	1.63	2.54	47.71	47.94	10	10	2.18	1.89
TCH	71.18	71.10	14	15	4.15	3.31	61.60	60.75	10	10	1.88	2.73
TTB	28.67	29.22	12	14	1.55	1.71	25.88	26.11	10	10	1.82	1.16

SULLY

Dimension	MALES						FEMALES					
	Mean		n	Std. Dev.		Mean		n	Std. Dev.			
	left	right		left	right	left	right		left	right		
BBH	131.22		9	3.07		126.00		6	6.75			
GBL	176.80		10	7.00		168.50		6	7.66			
EUB	141.70		10	7.02		134.83		6	2.99			
UFH	84.47		11	4.15		75.10		6	4.42			
NAH	33.91		11	2.48		30.91		6	3.65			
NAW	25.96		11	1.43		25.64		6	1.67			
ZYG	136.73		11	7.52		130.33		6	7.55			
JNB	24.57		9	2.70		21.99		6	3.70			
CML	158.80	163.07	10	7	8.35	7.48	138.10	132.30	5	5	5.33	3.44
CAPD	10.93	11.98	10	7	1.05	.80	9.60	9.84	5	5	0.58	0.81
CSID	9.88	9.89	10	7	1.12	1.15	8.98	9.11	5	5	0.63	1.43
C1	12.21		10	1.09		9.89		7	0.77			
XC2	37.60		9	2.51		35.83		7	5.54			
XC3	13.72		9	0.77		11.19		6	0.72			
XC4	13.13		11	0.73		11.53		5	1.03			
XC5	12.92		10	1.09		10.99		6	0.80			
XC6	13.32		10	1.18		11.50		6	0.44			
XC7	14.99		10	1.33		13.15		6	0.48			
XT1	17.17		11	1.22		14.88		6	1.21			
XT2	18.38		11	0.93		15.89		7	1.09			
XT3	18.22		11	0.83		16.12		7	0.42			
XT4	18.86		11	0.97		16.32		7	1.33			
XT5	19.46		12	0.85		17.31		7	0.64			
XT6	20.43		10	0.84		17.95		7	0.77			
XT7	21.07		10	0.77		18.51		7	0.55			
XT8	21.58		11	0.73		19.35		7	0.84			
XT9	22.26		12	0.91		20.13		7	0.45			
XT10	22.87		12	1.00		20.37		7	0.47			
XT11	23.47		9	1.01		21.49		7	0.83			
XT12	25.27		9	1.31		23.31		7	0.97			
XL1	26.79		12	1.62		24.99		7	0.88			
XL2	27.07		12	1.78		25.81		7	1.10			
XL3	27.91		12	1.85		26.27		7	1.01			
XL4	28.85		12	2.01		27.02		7	1.66			

SULLY, CONTINUED

Dimension	MALES						FEMALES					
	Mean		<i>n</i>		Std. Dev.		Mean		<i>n</i>		Std. Dev.	
	left	right			left	right	left	right			left	right
XL5	29.16		12		1.96		27.86		7		1.27	
S1	31.34		11		3.08		28.45		8		2.06	
SML	105.69		6		7.10		107.00		5		8.12	
HML	318.33	323.77	9	11	9.00	11.49	286.67	289.33	6	6	10.35	6.95
HEB	59.64	61.18	7	11	2.39	2.25	55.17	55.33	6	6	2.54	2.32
HHD	46.39	47.29	9	11	1.91	2.06	40.13	40.29	6	6	0.81	1.12
HMLD	21.41	22.12	9	11	1.31	2.81	18.68	19.09	6	6	0.27	0.45
HAPD	19.87	21.47	9	11	1.73	1.89	18.12	18.96	6	6	0.90	1.34
HAB	42.16	40.70	5	10	2.44	2.07	37.35	36.30	6	5	1.82	1.41
RML	254.17	255.46	9	11	10.53	8.94	224.00	229.29	3	7	6.00	6.05
RMLD	14.48	15.09	9	11	0.89	0.84	12.53	14.00	3	7	1.41	1.52
RAPD	11.72	11.98	9	11	0.87	0.90	10.47	10.87	3	7	0.84	0.66
RMLH	21.33	21.69	9	12	1.17	0.73	19.02	19.32	4	7	1.02	0.58
RAPH	21.97	22.65	8	11	1.49	0.94	19.75	19.86	4	6	1.08	0.43
RAB	25.49	26.42	11	11	1.20	1.14	24.22	24.18	3	7	1.05	0.83
UML	270.14	273.50	7	9	11.43	9.06	242.70	246.75	5	4	9.56	4.27
UMLD	12.37	12.99	7	9	0.95	0.76	11.94	11.00	5	4	0.75	0.70
UAPD	14.32	15.22	7	9	1.04	1.14	13.35	14.21	5	4	0.83	1.55
FML	444.10	445.17	10	12	12.77	12.21	406.13	406.06	8	8	11.12	11.92
FBL	441.10	441.75	10	12	12.64	12.48	398.50	397.14	7	7	8.05	7.22
FEB	81.44	82.41	9	11	2.24	2.34	72.00	72.43	6	7	1.05	1.59
FAB	71.80	72.60	9	12	2.15	1.94	62.18	62.35	7	7	2.22	1.30
FHD	45.90	46.33	10	12	1.17	1.66	41.90	42.01	8	8	1.17	1.36
FMLD	27.97	27.31	10	12	1.97	2.25	24.82	23.50	8	8	1.30	1.09
FAPD	30.08	30.45	10	12	1.71	1.95	25.60	25.38	8	8	1.70	1.41
TML	382.09	385.25	11	12	13.52	13.47	347.14	348.56	7	8	14.33	12.96
TFL	379.95	382.13	12	12	13.58	13.91	344.07	345.31	7	8	14.11	12.52
TPB	76.95	76.50	10	12	1.71	1.95	66.88	67.20	4	5	1.65	1.79
TPAB	75.03	75.18	10	12	2.36	2.21	65.67	65.93	4	5	1.56	1.18
TMLD	24.64	24.77	12	12	1.90	1.41	21.56	21.70	7	8	1.16	1.46
TAPD	30.10	29.77	12	12	1.82	1.74	24.35	23.86	7	8	1.47	1.59
FIML	374.33	378.22	9	9	13.31	13.33	332.25	331.20	6	5	8.63	6.30
BIB	279.46		12		11.10		258.81		8		15.05	
IBL	159.25	161.50	8	6	4.95	5.89	148.00	149.83	6	6	4.69	7.83
ACH	51.70	50.67	11	10	1.92	2.23	48.01	47.99	7	7	1.18	1.56
TCH	71.42	72.33	6	6	3.77	4.13	63.42	63.50	6	7	3.44	2.18
TTB	29.47	29.99	6	7	0.46	1.26	26.34	26.10	6	7	0.92	1.10

AVERBUCH

Dimension	MALES						FEMALES					
	Mean		<i>n</i>	Std. Dev.		Mean		<i>n</i>	Std. Dev.			
	left	right		left	right	left	right		left	right		
BBH	142.84		19	4.91		139.58		26	6.07			
GBL	164.05		19	6.62		155.40		25	8.43			
EUB	148.58		19	4.34		144.67		27	7.01			
UFH	84.80		15	4.39		79.29		24	4.67			
NAH	31.52		10	1.71		27.95		13	1.57			
NAW	24.82		18	2.00		25.06		24	1.78			
ZYG	142.53		17	3.76		132.76		25	5.25			
JNB	31.46		17	3.14		29.53		20	3.03			
CML	155.66	158.14	25	21	11.13	8.48	143.42	144.03	24	20	10.00	9.65
CAPD	11.89	11.71	26	21	1.41	0.99	10.42	10.48	24	20	1.19	1.10
CSID	10.59	10.55	26	21	2.02	1.89	9.13	9.07	24	20	0.97	1.31
C1	10.94		18	1.38		10.55		24	1.18			
XC2	36.59		21	2.44		34.31		22	2.78			
XC3	13.04		21	1.13		12.74		22	1.08			
XC4	13.33		20	1.08		12.27		20	.84			
XC5	12.95		21	1.02		12.42		19	.87			
XC6	13.42		25	1.26		12.75		25	1.05			
XC7	14.88		24	1.11		14.38		24	.90			
XT1	17.25		24	1.04		16.26		25	.74			
XT2	19.05		26	0.83		17.56		25	.92			
XT3	18.63		26	0.93		17.12		24	1.00			
XT4	19.02		25	1.25		17.70		23	.86			
XT5	19.74		25	1.10		18.25		24	.80			
XT6	20.64		23	1.20		18.98		24	.92			
XT7	21.21		24	1.28		19.20		25	1.15			
XT8	21.64		25	1.08		19.48		26	1.06			
XT9	22.10		25	1.45		20.21		25	1.03			
XT10	22.74		25	1.81		20.86		25	1.12			
XT11	23.31		26	1.23		21.64		26	1.31			
XT12	25.13		26	1.24		23.73		26	1.54			
XL1	26.35		27	1.17		25.22		26	1.55			
XL2	27.26		26	1.37		26.31		26	1.45			
XL3	28.36		26	1.64		28.19		25	8.07			
XL4	29.03		27	1.68		27.46		24	1.37			

AVERBUCH, CONTINUED

Dimension	MALES						FEMALES					
	Mean		<i>n</i>		Std. Dev.		Mean		<i>n</i>		Std. Dev.	
	left	right			left	right	left	right			left	right
XL5	29.39		27		1.71		27.96		25		1.32	
S1	30.89		26		1.73		29.90		26		2.42	
SML	109.49		17		8.16		108.60		10		5.94	
HML	326.73	325.06	22	24	14.07	14.75	302.14	305.57	28	27	15.65	14.61
HEB	60.22	61.36	23	25	3.72	3.41	53.67	54.80	27	25	3.49	3.67
HHD	45.52	45.85	23	24	2.09	2.11	39.72	40.16	28	27	2.83	2.87
HMLD	21.12	22.60	24	25	1.95	1.80	19.03	18.88	28	27	1.97	2.23
HAPD	20.39	21.82	24	25	2.08	1.60	20.20	20.26	28	27	1.63	1.72
HAB	43.40	43.38	24	25	2.56	2.23	39.14	39.48	27	28	2.29	2.22
RML	254.59	253.74	22	25	11.24	12.48	230.44	233.22	24	25	15.76	14.84
RMLD	15.21	15.44	23	25	1.24	1.27	14.33	14.65	24	26	1.56	1.46
RAPD	12.48	12.79	23	25	1.22	0.94	11.09	11.35	24	26	1.09	0.98
RMLH	21.37	21.95	22	25	1.33	1.26	19.10	19.51	23	25	1.14	1.11
RAPH	22.11	22.35	22	24	1.44	1.32	20.01	20.05	24	25	1.16	1.07
RAB	25.46	25.66	20	23	1.52	1.62	23.74	24.00	23	24	1.40	1.43
UML	273.43	274.44	22	23	12.09	12.46	246.77	249.56	22	25	13.09	14.88
UMLD	13.04	13.54	23	23	0.95	1.14	11.23	11.41	21	25	1.17	1.19
UAPD	15.26	15.76	23	23	1.37	1.35	13.94	15.05	21	25	1.42	1.72
FML	451.32	450.26	27	27	20.97	20.62	428.06	424.40	27	26	18.52	21.43
FBL	448.67	447.33	27	27	20.75	20.41	423.80	420.67	27	26	19.04	21.54
FEB	80.85	81.26	26	25	3.32	3.73	74.33	73.80	23	25	5.07	5.19
FAB	71.49	71.60	27	27	3.06	3.25	65.03	64.48	25	25	4.82	4.98
FHD	46.19	46.04	27	27	2.53	2.36	41.09	41.02	28	25	2.61	2.69
FMLD	27.83	27.60	27	27	2.40	2.56	25.17	24.55	26	26	1.39	1.73
FAPD	29.38	29.22	27	27	2.18	2.53	27.08	27.08	26	26	2.62	2.65
TML	376.00	376.52	26	26	19.00	19.38	352.24	352.56	25	24	18.53	24.00
TFL	371.74	372.15	26	26	18.94	19.50	347.86	348.64	25	25	18.45	23.31
TPB	76.34	76.21	22	19	3.39	2.83	68.40	69.12	24	25	4.27	4.64
TPAB	74.12	74.20	25	21	3.21	2.61	67.01	66.68	25	25	4.30	4.83
TMLD	23.19	24.34	24	27	2.94	2.18	20.41	21.82	23	23	2.08	1.82
TAPD	28.34	28.38	25	27	2.29	2.03	25.61	25.39	23	23	2.40	2.50
FIML	363.43	361.68	15	17	21.90	22.83	337.56	338.92	17	18	16.86	21.18
BIB	275.40		25		15.94		266.11		23		15.05	
IBL	154.17	152.75	18	20	7.25	7.97	147.70	146.20	20	20	8.18	7.41
ACH	51.96	51.34	25	25	2.53	2.74	47.05	46.78	26	27	2.48	2.92
TCH	66.91	67.74	23	21	3.22	3.58	60.61	61.46	23	26	4.18	4.17
TTB	31.27	31.01	24	23	2.07	2.06	28.30	28.50	23	27	1.91	1.75

CANDY CREEK AND LEDBETTER LANDING

Dimension	MALES						FEMALES					
	Mean		n		Std. Dev.		Mean		n		Std. Dev.	
	left	right			left	right	left	right			left	right
BBH	138.64		11		5.92		134.25		4		4.35	
GBL	178.50		12		5.73		171.75		4		3.30	
EUB	138.42		12		4.46		138.25		4		3.69	
UFH	77.36		8		4.32		76.46		3		3.75	
NAH	27.68		8		3.06		25.40		3		1.30	
NAW	25.68		8		.96		23.51		4		1.37	
ZYG	137.78		9		4.35		130.33		3		7.77	
JNB	24.30		9		2.27		21.19		2		3.33	
CML	151.75	149.82	10	11	10.01	8.12	138.17	138.50	3	1	3.18	
CAPD	11.09	11.56	10	11	1.26	0.96	9.95	10.89	3	1	0.66	
CSID	9.30	10.29	10	11	0.89	1.43	8.43	9.17	3	1	0.49	
C1	11.30		8		0.58		10.36		1			
XC2	35.80		10		2.45		33.28		2		2.10	
XC3	15.10		11		8.28		11.24		2		1.19	
XC4	11.99		9		0.93		10.68		2		1.77	
XC5	11.57		10		0.85		11.22		2		0.97	
XC6	12.71		11		0.64		11.89		3		0.80	
XC7	14.47		11		0.99		13.92		3		0.36	
XT1	16.62		12		1.05		15.90		3		0.14	
XT2	18.08		10		1.58		17.65		3		0.78	
XT3	18.26		10		1.52		17.75		3		0.65	
XT4	18.62		10		1.99		17.97		3		0.07	
XT5	19.14		10		1.42		18.59		3		0.39	
XT6	20.00		10		1.67		18.74		3		0.69	
XT7	20.98		11		1.59		19.54		3		0.16	
XT8	21.41		12		1.47		19.50		3		0.26	
XT9	21.99		13		1.27		20.21		3		0.35	
XT10	22.82		13		1.50		21.38		3		0.73	
XT11	23.15		13		1.40		22.28		2		0.06	
XT12	24.62		13		1.24		24.16		2		0.20	
XL1	26.28		13		1.85		26.02		3		0.72	
XL2	26.57		12		1.80		27.37		3		1.08	
XL3	26.99		13		1.13		28.50		2		1.29	
XL4	28.25		13		1.44		28.97		2		1.94	

CANDY CREEK AND LEDBETTER LANDING, CONTINUED

Dimension	MALES						FEMALES					
	Mean		n		Std. Dev.		Mean		n		Std. Dev.	
	left	right			left	right	left	right			left	right
XL5	28.53		13		1.30		29.50		2		2.38	
S1	30.39		13		1.79		29.28		1			
SML	109.68		4		5.62							
HML	315.65	318.83	10	9	12.09	9.92	293.75	298.25	2	2	15.91	13.08
HEB	59.23	60.45	11	10	3.04	2.95	55.00	56.50	1	1		
HHD	44.55	44.72	10	10	2.72	2.82	39.40	40.79	2	2	2.24	0.17
HMLD	20.50	21.24	10	9	1.68	1.18	18.05	19.20	2	2	0.79	1.51
HAPD	19.49	20.96	10	9	1.92	1.05	18.29	19.86	2	2	1.32	0.21
HAB	41.03	41.69	10	10	1.64	2.87	35.43	35.73	3	2	0.91	2.74
RML	243.00	250.36	9	7	15.17	10.95	223.33	225.00	3	1	0.58	
RMLD	13.54	15.05	9	7	1.05	0.52	13.80	15.06	3	1	1.22	
RAPD	11.43	11.78	9	7	0.44	0.61	11.02	12.07	3	1	1.10	
RMLH	21.02	21.39	11	10	0.76	1.18	19.07	19.30	2	2	0.42	0.37
RAPH	22.00	22.00	10	9	1.29	1.32	19.75	19.77	2	2	0.23	0.73
RAB	24.06	25.00	10	9	0.92	1.44	22.32	23.78	3	1	2.07	
UML	266.25	266.00	6	8	19.47	14.28	238.25	237.00	2	1	2.47	
UMLD	11.84	13.45	6	8	0.65	0.60	11.72	12.27	2	1	1.73	
UAPD	13.90	14.28	6	8	1.11	0.92	14.10	15.90	2	1	1.92	
FML	442.12	443.65	13	10	14.53	13.96	412.17	406.17	3	3	13.29	9.46
FBL	438.69	440.70	13	10	13.40	14.10	407.00	401.50	3	3	13.08	9.18
FEB	78.63	79.05	12	11	2.75	3.24	71.00	71.50	3	3	4.00	3.04
FAB	68.20	68.55	13	11	3.49	3.46	61.36	62.75	3	3	3.35	3.19
FHD	44.68	45.01	13	10	1.62	1.30	40.41	40.58	3	3	0.81	0.77
FMLD	26.33	26.19	13	10	2.92	1.33	24.36	23.65	3	3	0.64	0.53
FAPD	29.15	28.66	13	10	1.70	1.73	25.38	26.30	3	3	1.68	1.18
TML	375.46	377.19	11	8	10.71	9.64	344.33	344.17	3	3	4.16	2.93
TFL	370.80	369.72	10	9	10.09	10.97	339.33	337.67	3	3	4.04	1.15
TPB	73.22	71.93	9	7	2.24	2.35	65.17	64.67	3	3	2.25	2.31
TPAB	71.30	70.42	9	7	1.86	2.64	63.04	63.06	3	3	3.19	2.72
TMLD	22.80	23.95	11	9	2.48	2.20	21.94	21.59	3	3	3.06	2.72
TAPD	31.11	30.00	11	9	1.69	1.84	27.25	27.49	3	3	3.70	2.43
FIML	371.50	363.50	1	3		15.76	320.00	322.00	1	1		
BIB	275.50		7		11.31		259.25		2		0.35	
IBL	151.00	152.00	7	6	8.56	10.41	143.00	143.50	2	2	2.83	0.71
ACH	49.47	49.24	12	9	1.90	2.62	45.76	44.68	3	3	1.10	1.05
TCH	63.50	66.05	8	10	4.48	3.53	58.50	59.50	2	2	4.95	2.12
TTB	29.84	30.30	11	10	1.38	1.51	27.91	28.46	3	3	0.82	0.46

CHERRY

Dimension	MALES						FEMALES					
	Mean		n	Std. Dev.		Mean		n	Std. Dev.			
	left	right		left	right	left	right		left	right		
BBH	140.27		11	4.47		134.20		5	5.07			
GBL	180.00		12	5.39		173.60		5	4.04			
EUB	135.83		12	2.55		130.80		5	4.97			
UFH	78.82		12	4.22		68.92		5	5.08			
NAH	26.05		12	2.67		23.81		4	2.95			
NAW	22.98		12	1.98		20.69		4	1.28			
ZYG	136.50		12	5.05		127.25		4	4.03			
JNB	25.01		9	4.47		20.88		4	3.05			
CML	148.57	146.91	14	11	7.67	7.20	130.00	127.30	5	5	5.43	4.09
CAPD	11.17	11.67	14	11	1.09	0.57	9.10	9.14	5	5	1.25	1.26
CSID	9.65	9.83	14	11	1.59	0.81	8.01	8.07	5	5	0.89	0.98
C1	11.13		11	1.03		8.78		4	0.67			
XC2	35.35		12	1.96		34.06		3	2.04			
XC3	12.03		12	1.00		11.01		3	1.97			
XC4	11.65		12	1.05		10.14		3	0.28			
XC5	11.66		13	1.25		10.34		3	0.77			
XC6	11.77		13	0.89		10.47		5	0.85			
XC7	13.17		13	1.05		12.32		5	0.53			
XT1	15.42		14	0.66		14.22		4	0.71			
XT2	16.88		14	1.08		16.00		4	1.45			
XT3	17.76		15	0.92		16.05		3	0.93			
XT4	18.16		15	1.26		16.78		3	0.58			
XT5	19.13		15	1.32		17.53		2	0.85			
XT6	19.85		15	1.24		18.36		3	0.57			
XT7	20.54		15	1.14		19.05		5	0.54			
XT8	21.12		15	1.05		19.32		4	1.50			
XT9	21.67		15	1.00		20.34		4	0.90			
XT10	22.40		14	1.20		20.46		3	1.11			
XT11	23.63		15	4.31		21.35		4	1.19			
XT12	24.31		15	1.56		22.80		4	1.32			
XL1	25.51		15	1.42		24.32		5	1.22			
XL2	26.21		15	1.57		24.56		5	1.13			
XL3	26.51		15	1.92		25.33		5	0.77			
XL4	27.50		15	1.46		25.81		5	1.25			

CHERRY, CONTINUED

Dimension	MALES						FEMALES					
	Mean		n		Std. Dev.		Mean		n		Std. Dev.	
	left	right			left	right	left	right			left	right
XL5	27.78		15		1.83		25.51		5		1.66	
S1	29.97		15		2.08		28.11		5		1.69	
SML	106.65		7		8.23		103.80		2		7.61	
HML	315.18	316.09	14	11	18.68	16.57	291.63	298.67	4	3	16.29	12.74
HEB	57.80	58.73	15	13	3.03	3.09	50.75	52.67	4	3	2.22	3.40
HHD	43.70	44.22	14	13	2.24	1.82	38.17	38.22	4	3	3.34	2.28
HMLD	20.47	22.46	14	11	1.80	2.07	15.52	17.35	4	3	1.26	0.92
HAPD	18.97	20.94	14	11	1.87	2.15	16.67	18.22	4	3	2.69	1.94
HAB	40.27	41.72	15	13	2.82	2.28	35.30	34.94	4	3	2.29	2.70
RML	246.33	246.64	15	11	17.25	17.10	218.60	216.75	5	2	13.83	5.30
RMLD	13.35	13.73	15	12	1.14	1.25	11.74	11.62	5	2	1.11	0.49
RAPD	11.44	11.56	15	12	1.08	0.88	9.31	9.46	5	2	0.68	0.10
RMLH	20.50	20.76	13	13	0.99	0.95	17.71	17.78	5	3	1.35	0.67
RAPH	21.35	21.80	14	13	1.08	1.10	18.33	17.63	5	3	1.27	1.21
RAB	23.34	23.56	15	12	1.70	1.67	21.25	21.98	5	4	0.81	1.70
UML	263.08	266.85	13	10	17.17	17.67	240.38	238.33	4	3	10.67	10.21
UMLD	12.02	12.75	13	10	0.87	1.15	10.62	10.78	4	3	0.58	0.52
UAPD	14.15	13.80	13	10	1.06	1.16	11.79	12.05	4	3	1.19	1.11
FML	441.04	437.40	12	15	26.92	26.78	398.00	411.13	3	4	13.26	12.14
FBL	437.33	433.73	12	15	26.42	24.80	392.67	405.88	3	4	10.50	13.63
FEB	76.85	76.07	13	13	3.50	2.86	69.00	69.33	3	3	1.50	1.53
FAB	67.20	68.56	14	14	2.88	2.53	58.36	59.16	3	3	0.32	2.26
FHD	43.67	43.53	14	15	2.22	2.10	38.38	38.55	5	5	1.09	1.48
FMLD	23.81	24.31	13	15	1.62	1.61	22.63	22.92	3	4	0.48	0.71
FAPD	28.54	28.15	13	15	2.04	2.02	22.37	24.32	3	4	2.31	2.45
TML	369.80	366.31	15	13	24.64	24.57	338.00	335.50	2	3	11.31	15.06
TFL	364.73	364.07	15	14	24.55	25.28	332.75	332.00	2	3	10.96	14.11
TPB	72.47	72.13	15	12	4.12	3.15	64.17	63.50	3	3	1.15	0.50
TPAB	70.51	70.95	15	12	3.73	3.32	61.74	62.91	3	3	1.10	0.64
TMLD	20.95	22.85	15	14	1.54	2.48	19.00	19.07	2	3	2.52	2.14
TAPD	29.44	27.65	15	14	1.94	1.78	23.66	22.99	2	3	0.88	1.07
FIML	341.50	355.11	5	9	13.31	20.95	330.00	315.75	1	2		13.08
BIB	255.58		13		11.01		247.83		3		5.06	
IBL	149.43	150.11	7	9	11.30	10.23	145.67	143.67	3	3	8.08	8.96
ACH	48.88	47.21	9	11	3.23	3.11	43.78	43.84	4	5	0.86	1.24
TCH	64.12	65.82	13	14	4.74	4.06	56.30	58.13	5	4	2.77	3.07
TTB	29.00	28.85	15	14	1.67	1.52	27.42	26.41	5	4	0.88	1.04

EBENEZER AND ROBINSON

Dimension	MALES						FEMALES					
	Mean		n	Std. Dev.		Mean		n	Std. Dev.			
	left	right		left	right	left	right		left	right		
BBH	140.60		5	2.30		140.50		2	3.54			
GBL	180.60		5	10.19		171.50		2	4.95			
EUB	140.40		5	4.93		136.00		2	4.24			
UFH	77.46		1									
NAH	28.18		1									
NAW	24.33		2	0.43		22.44		1				
ZYG	140.00		2	2.83								
JNB	25.61		6	4.64		27.84		3	1.24			
CML	147.17	143.00	9	10	9.07	8.06	147.00	144.67	4	3	6.48	8.14
CAPD	10.99	11.58	9	10	1.49	1.56	10.04	10.41	4	3	1.06	0.46
CSID	9.26	9.46	9	10	0.80	1.19	8.41	8.51	4	3	1.23	0.65
C1	10.86		7	0.54		10.60		2	0.16			
XC2	35.44		8	3.36		34.37		3	2.96			
XC3	12.61		8	1.22		12.00		3	1.05			
XC4	12.49		7	1.49		11.75		3	0.20			
XC5	11.89		8	0.99		11.35		4	0.66			
XC6	12.05		10	1.08		11.65		4	0.29			
XC7	13.86		10	0.73		13.21		4	0.23			
XT1	16.28		10	0.99		15.69		4	0.47			
XT2	17.78		9	1.18		16.50		4	1.03			
XT3	17.99		8	1.19		17.17		3	1.14			
XT4	18.76		8	1.45		17.52		3	1.12			
XT5	19.15		7	1.15		18.79		4	0.80			
XT6	20.16		8	1.16		19.34		4	1.15			
XT7	21.31		8	1.66		19.79		4	1.12			
XT8	22.03		7	2.10		20.25		4	0.77			
XT9	22.56		7	1.98		20.82		4	1.38			
XT10	23.02		8	1.74		21.32		4	0.94			
XT11	23.52		9	2.08		22.63		4	1.36			
XT12	25.02		9	2.86		24.28		4	1.51			
XL1	26.54		9	2.46		25.98		5	1.38			
XL2	26.43		9	2.45		26.06		5	1.17			
XL3	26.75		9	1.68		26.87		5	1.19			
XL4	28.29		9	1.56		27.41		5	1.02			

EBENEZER AND ROBINSON, CONTINUED

Dimension	MALES						FEMALES					
	Mean		<i>n</i>		Std. Dev.		Mean		<i>n</i>		Std. Dev.	
	left	right			left	right	left	right			left	right
XL5	28.30		9		1.76		28.67		5		1.48	
S1	30.94		8		1.96		31.61		4		1.15	
SML	118.16		1				88.28		1			
HML	328.75	329.56	6	9	27.62	19.84	313.17	304.25	3	4	3.62	12.87
HEB	58.83	59.94	6	9	3.98	3.91	54.17	53.90	3	5	2.47	2.41
HHD	42.85	43.76	9	9	3.58	3.37	38.88	38.97	3	3	3.57	3.40
HMLD	19.90	21.48	8	9	1.99	2.67	19.07	19.52	3	4	.60	2.04
HAPD	19.22	21.23	8	9	1.52	1.75	18.21	19.35	3	4	1.23	1.90
HAB	39.49	42.04	6	8	3.92	2.93	39.22	39.23	4	5	2.71	2.05
RML	249.92	254.00	6	8	23.29	19.21	235.90	244.67	5	3	15.17	9.29
RMLD	14.17	14.55	6	8	1.22	1.01	12.08	13.09	5	3	1.14	0.32
RAPD	11.51	11.66	6	8	1.21	1.16	10.37	10.91	5	3	0.80	1.07
RMLH	20.83	21.78	6	8	1.29	1.35	19.69	20.35	5	3	1.79	1.22
RAPH	21.77	22.76	6	8	1.74	1.50	20.05	21.39	5	3	2.09	1.51
RAB	24.04	24.31	6	8	1.19	1.11	23.23	23.75	4	4	1.16	1.40
UML	270.83	270.58	6	6	22.60	23.99	254.25	262.38	4	4	20.22	9.23
UMLD	12.65	12.55	6	6	1.27	0.81	10.75	11.31	4	4	1.00	1.39
UAPD	13.09	14.54	6	6	1.75	1.37	12.79	13.70	4	4	0.56	0.89
FML	453.21	447.75	7	10	34.64	30.76	426.90	410.50	5	2	24.76	34.65
FBL	446.69	444.55	8	10	33.47	30.66	422.10	406.75	5	2	24.90	35.00
FEB	78.20	76.39	5	9	4.96	4.66	72.20	71.00	5	4	3.75	3.74
FAB	70.39	67.76	5	9	4.22	3.48	63.50	62.26	5	4	4.51	3.83
FHD	43.16	43.27	11	11	3.03	3.05	40.22	38.81	5	3	1.86	1.19
FMLD	25.07	24.79	8	10	1.45	1.60	23.82	22.82	5	3	0.84	0.63
FAPD	29.34	28.45	8	10	2.62	2.87	27.25	26.24	5	3	1.88	1.88
TML	382.00	380.10	7	10	29.73	26.64	360.83	356.20	3	5	14.29	16.70
TFL	377.64	375.40	7	10	29.27	26.00	358.50	352.20	3	5	14.77	17.02
TPB	71.00	72.31	4	8	4.32	4.83	67.67	66.90	3	5	4.51	3.81
TPAB	69.11	70.47	4	8	3.25	4.77	66.58	65.09	3	5	4.59	3.68
TMLD	21.49	23.40	8	10	1.81	2.44	19.90	21.21	3	5	1.59	2.55
TAPD	27.68	28.08	8	10	2.86	3.06	26.14	24.40	3	5	1.09	1.87
FIML	343.00	364.00	1	3		42.46	319.00	351.00	1	2		14.14
BIB	268.40		5		9.94		260.00		3		5.57	
IBL	153.20	155.00	5	3	12.40	15.39	151.50	147.50	2	4	7.78	5.51
ACH	48.61	51.58	6	4	4.59	5.97	46.08	43.84	3	2	2.85	1.72
TCH	65.06	65.05	9	10	4.53	4.82	60.25	61.10	4	5	4.43	4.34
TTB	29.97	30.34	11	10	1.82	1.31	28.12	28.89	5	4	0.64	1.09

EVA

Dimension	MALES						FEMALES					
	Mean		n	Std. Dev.		Mean		n	Std. Dev.			
	left	right		left	right	left	right		left	right		
BBH	138.88		17	3.84		132.42		12	3.23			
GBL	175.50		18	5.09		171.85		13	5.01			
EUB	135.50		18	2.96		133.39		13	4.11			
UFH	76.53		17	3.89		75.56		12	4.97			
NAH	26.29		17	1.66		25.98		12	1.98			
NAW	23.29		17	1.91		23.69		12	1.34			
ZYG	135.06		18	5.95		129.25		12	4.41			
JNB	24.92		12	3.26		22.06		8	1.74			
CML	145.07	141.30	15	15	10.96	12.77	136.18	134.92	11	12	9.46	10.48
CAPD	11.31	11.62	15	14	1.27	1.44	9.68	9.73	11	12	.86	.91
CSID	9.20	9.57	15	14	1.25	1.90	8.11	8.01	11	12	.89	.76
C1	11.32		15	0.77		10.70		10	0.81			
XC2	34.58		19	3.19		32.55		13	2.14			
XC3	11.73		19	1.07		11.24		13	1.16			
XC4	11.19		19	1.49		10.68		13	1.00			
XC5	11.03		18	1.40		10.75		13	1.06			
XC6	11.72		18	0.65		11.00		13	.92			
XC7	13.07		18	0.92		12.32		13	1.07			
XT1	15.26		17	1.39		14.50		13	.94			
XT2	16.96		17	1.30		16.11		13	.59			
XT3	17.36		17	1.23		16.32		12	.62			
XT4	17.98		17	0.95		17.03		11	1.00			
XT5	18.97		18	1.36		17.84		11	1.27			
XT6	19.72		18	1.50		18.52		12	1.06			
XT7	20.22		19	1.32		19.16		13	1.03			
XT8	20.68		18	1.50		19.39		13	.98			
XT9	21.07		18	1.44		19.77		12	1.10			
XT10	21.49		19	1.31		20.34		12	.98			
XT11	22.51		19	1.33		21.13		13	1.20			
XT12	24.46		19	1.48		22.93		13	1.36			
XL1	25.43		19	1.83		24.03		13	1.46			
XL2	25.66		19	1.55		24.92		13	1.43			
XL3	26.44		19	1.62		26.69		13	3.23			
XL4	27.18		19	1.84		26.44		12	1.37			

EVA, CONTINUED

Dimension	MALES						FEMALES					
	Mean		<i>n</i>		Std. Dev.		Mean		<i>n</i>		Std. Dev.	
	left	right			left	right	left	right			left	right
XL5	27.55		19		1.66		27.16		13		1.44	
S1	30.17		17		1.67		28.71		12		2.19	
SML	111.88		6		7.74		104.99		2		8.91	
HML	309.77	308.66	15	16	12.82	19.30	291.30	294.30	10	10	9.94	13.50
HEB	56.91	58.11	17	18	3.34	3.16	51.68	52.14	11	11	3.86	3.12
HHD	43.46	43.66	17	16	2.93	2.96	39.17	38.86	12	11	2.13	1.65
HMLD	20.17	20.78	15	16	0.92	1.85	17.03	18.00	11	10	1.37	2.00
HAPD	18.98	20.45	15	16	1.55	1.84	16.74	18.13	11	10	2.12	2.44
HAB	40.64	41.06	18	17	2.78	2.82	36.19	37.38	11	10	2.04	2.59
RML	243.25	242.13	14	16	17.99	16.34	222.31	224.20	8	10	9.02	13.25
RMLD	13.43	13.37	14	16	1.23	1.14	11.78	12.02	9	10	1.39	1.20
RAPD	11.15	11.24	14	16	0.68	1.03	9.52	9.71	9	10	0.47	0.96
RMLH	20.99	21.00	13	18	1.54	1.39	18.66	18.70	11	11	1.60	1.52
RAPH	21.75	21.59	14	18	1.79	1.32	19.06	19.42	13	11	1.51	1.55
RAB	23.87	23.77	17	17	1.78	1.86	21.48	22.21	10	8	1.54	1.23
UML	266.29	261.73	12	13	9.25	10.73	244.11	244.64	9	7	9.44	14.37
UMLD	12.19	12.60	12	14	1.09	0.82	10.92	10.68	9	7	0.47	0.93
UAPD	13.20	13.81	12	14	1.01	1.24	11.81	12.45	9	7	1.21	1.12
FML	434.16	439.25	19	16	24.89	20.64	409.83	411.05	12	11	20.40	22.85
FBL	430.13	435.50	19	16	25.55	20.97	406.17	407.09	12	11	20.66	23.10
FEB	76.14	76.19	18	18	4.20	3.88	69.35	69.92	13	12	3.07	3.40
FAB	66.31	67.31	19	18	4.78	3.93	60.68	61.16	13	11	3.80	3.50
FHD	43.33	43.41	19	18	2.72	2.69	39.34	39.45	13	12	1.84	1.91
FMLD	24.16	24.52	18	16	1.35	1.29	23.23	23.45	12	11	1.44	1.41
FAPD	26.73	26.85	18	16	2.99	2.28	22.94	23.07	12	11	1.61	1.49
TML	365.43	363.80	15	15	15.59	22.23	344.46	343.22	11	9	20.55	17.96
TFL	361.07	359.10	15	15	14.97	22.12	339.59	338.61	11	9	20.59	18.54
TPB	71.53	70.82	15	14	4.91	4.98	65.15	64.32	10	11	3.66	2.40
TPAB	69.46	68.66	16	14	4.94	4.74	63.38	63.01	10	11	3.53	2.77
TMLD	20.75	21.85	15	15	1.67	1.37	18.08	18.77	11	9	1.71	1.04
TAPD	28.16	27.14	15	15	2.35	2.10	23.54	23.18	11	9	1.98	2.05
FIML	353.83	345.21	6	7	17.66	16.33	339.50	332.38	1	4		22.66
BIB	252.67		9		11.71		259.40		5		11.48	
IBL	147.67	146.00	6	3	6.09	6.25	143.75	141.83	4	6	12.34	9.62
ACH	49.24	48.10	6	8	2.66	2.05	45.19	43.88	5	7	1.28	1.68
TCH	62.61	63.47	18	17	4.30	4.35	56.55	57.92	10	13	3.21	3.15
TTB	28.74	28.87	19	18	1.67	1.63	26.34	26.19	12	13	1.43	1.66

HIWASSEE

Dimension	MALES						FEMALES					
	Mean		n	Std. Dev.		Mean		n	Std. Dev.			
	left	right		left	right	left	right		left	right		
BBH	141.00		15	4.91		135.33		15	4.81			
GBL	166.71		14	10.65		160.53		15	12.26			
EUB	152.79		14	9.63		149.53		15	11.84			
UFH	82.69		9	3.65		79.13		13	3.98			
NAH	30.31		7	2.60		27.42		9	2.63			
NAW	25.23		13	1.67		24.84		16	1.61			
ZYG	138.58		12	4.94		131.62		13	6.02			
JNB	29.52		15	2.93		27.03		14	3.60			
CML	153.55	151.29	20	17	9.12	8.35	139.75	137.97	18	18	8.22	7.36
CAPD	11.30	11.27	20	17	1.23	0.95	9.99	10.69	18	18	1.22	1.28
CSID	9.96	10.14	20	17	1.31	1.27	8.74	8.88	18	18	1.23	1.41
C1	10.71		17	1.49		9.50		16	1.17			
XC2	35.53		17	2.98		32.80		17	2.40			
XC3	12.64		17	1.13		12.28		17	1.19			
XC4	12.66		13	1.43		12.50		18	0.87			
XC5	12.61		17	1.38		12.21		18	0.71			
XC6	13.29		19	1.12		12.63		18	0.57			
XC7	14.92		18	1.20		14.21		18	0.89			
XT1	16.68		17	1.23		15.85		19	1.09			
XT2	18.33		18	1.19		17.33		17	1.04			
XT3	18.33		17	0.81		17.28		17	1.03			
XT4	18.70		18	1.04		17.63		17	1.05			
XT5	19.46		19	0.98		18.06		17	1.28			
XT6	20.18		18	0.95		18.90		18	1.16			
XT7	20.90		19	1.05		19.19		18	1.04			
XT8	21.56		20	1.18		19.92		16	1.10			
XT9	22.28		20	1.25		20.36		16	1.10			
XT10	22.93		19	1.28		21.00		17	1.09			
XT11	23.41		19	1.39		21.60		18	1.78			
XT12	24.99		19	1.55		23.39		18	1.08			
XL1	26.61		20	1.24		25.23		19	1.26			
XL2	27.32		20	1.26		26.24		18	1.08			
XL3	28.00		19	1.24		26.78		18	1.63			
XL4	28.93		19	1.57		27.30		18	1.42			

HIWASSEE, CONTINUED

Dimension	MALES						FEMALES					
	Mean		<i>n</i>		Std. Dev.		Mean		<i>n</i>		Std. Dev.	
	left	right			left	right	left	right			left	right
XL5	28.87		20		1.12		27.67		18		1.37	
S1	31.05		20		1.88		30.38		19		1.80	
SML	112.17		14		7.94		110.52		11		8.59	
HML	321.80	322.76	20	19	13.51	14.85	299.83	302.36	18	18	15.00	12.22
HEB	58.61	59.68	18	19	3.60	3.98	52.78	53.74	18	19	1.65	2.32
HHD	44.33	44.94	20	18	3.02	3.52	39.51	39.99	16	18	1.93	2.23
HMLD	20.74	21.40	20	19	2.47	2.18	18.46	18.91	19	18	1.72	1.44
HAPD	20.52	20.87	20	19	1.96	2.27	19.97	20.23	19	18	1.68	1.75
HAB	43.04	42.37	18	19	2.75	3.09	38.21	38.54	18	19	1.70	1.73
RML	250.29	251.87	17	19	11.40	11.01	229.18	231.56	17	18	8.75	9.44
RMLD	14.20	14.69	18	19	1.70	1.87	13.73	14.52	18	18	1.76	1.59
RAPD	11.96	11.93	18	19	0.87	0.95	10.81	11.05	18	18	0.80	0.65
RMLH	20.96	21.63	16	18	1.42	1.69	18.68	19.42	17	17	1.01	1.35
RAPH	21.89	22.03	16	17	1.60	1.69	19.57	20.25	18	17	1.06	1.33
RAB	25.31	25.48	17	19	1.18	1.44	23.55	23.81	16	17	1.34	1.34
UML	268.56	272.25	16	16	10.69	10.60	248.33	250.43	18	17	9.12	10.20
UMLD	12.72	13.18	16	16	1.19	0.76	11.62	11.53	18	17	1.36	0.94
UAPD	15.39	15.28	16	16	1.05	1.86	14.52	15.22	18	17	1.34	1.38
FML	445.75	444.19	18	18	26.60	27.12	418.67	416.76	18	19	13.04	16.21
FBL	442.47	442.79	18	17	25.41	25.93	416.15	413.03	17	19	13.18	16.63
FEB	79.71	80.93	17	15	4.10	3.71	71.74	71.68	17	17	2.95	3.56
FAB	70.11	71.10	18	17	4.04	3.53	61.98	62.29	17	18	2.87	2.90
FHD	45.33	45.41	18	19	2.53	2.30	40.20	40.23	19	19	1.84	1.74
FMLD	25.82	25.64	18	18	2.36	1.74	24.20	23.92	18	19	1.48	1.53
FAPD	28.89	29.35	18	18	2.32	2.89	26.31	26.30	18	19	1.88	1.96
TML	370.32	371.00	19	18	21.27	21.41	344.16	343.68	16	17	10.87	12.47
TFL	366.04	367.26	19	18	21.08	20.89	339.18	339.11	16	17	10.14	12.50
TPB	75.13	75.68	19	14	4.10	3.58	66.69	67.41	16	16	2.61	2.90
TPAB	72.79	73.06	19	15	3.91	3.66	64.58	65.16	17	16	2.50	2.67
TMLD	22.38	23.98	19	18	2.19	2.34	20.58	22.02	18	16	2.14	2.39
TAPD	28.87	28.82	19	18	2.80	2.72	23.97	24.68	18	16	2.84	2.33
FIML	351.68	351.40	11	10	20.53	21.34	335.00	331.60	11	10	9.64	11.60
BIB	271.90		15		13.78		264.82		14		13.56	
IBL	151.73	153.36	15	11	7.81	7.02	144.62	144.13	13	16	8.10	7.94
ACH	51.01	50.12	19	18	2.83	2.85	46.26	45.90	19	17	2.03	1.92
TCH	65.61	66.58	19	18	4.12	3.59	58.78	59.73	16	15	3.33	3.25
TTB	30.16	30.88	19	19	2.18	2.60	27.13	27.51	16	19	1.63	1.78

LEDFORD LANDING

Dimension	MALES						FEMALES					
	Mean		n	Std. Dev.		Mean		n	Std. Dev.			
	left	right		left	right	left	right		left	right		
BBH	138.47		15	5.08		132.17		18	6.10			
GBL	166.33		15	10.95		156.67		18	8.88			
EUB	151.00		15	10.54		152.21		19	8.38			
UFH	80.15		14	3.88		75.78		14	7.17			
NAH	27.16		12	2.44		25.40		11	2.02			
NAW	23.69		17	1.78		24.05		15	1.92			
ZYG	138.86		14	4.80		133.88		17	7.46			
JNB	25.39		12	3.38		22.69		12	2.43			
CML	151.60	149.44	21	16	6.70	6.11	137.79	134.95	19	21	8.77	7.49
CAPD	10.81	11.61	21	15	0.97	1.05	9.47	9.70	19	21	0.74	0.90
CSID	9.50	9.83	21	15	1.10	1.49	8.52	8.60	19	21	1.24	0.96
C1	11.05		22	1.59		9.82		18	1.50			
XC2	35.37		22	2.36		33.07		19	2.35			
XC3	12.84		22	1.16		12.11		20	1.10			
XC4	12.28		20	1.11		11.71		20	0.81			
XC5	12.38		18	0.93		11.70		19	1.18			
XC6	12.93		20	0.99		11.86		18	1.03			
XC7	14.72		18	1.03		13.78		18	0.95			
XT1	16.89		20	1.10		15.75		19	1.06			
XT2	18.24		21	1.08		17.35		17	0.86			
XT3	18.15		20	1.24		17.39		17	0.98			
XT4	18.62		21	1.41		17.58		17	1.15			
XT5	19.44		21	1.11		18.05		18	0.74			
XT6	20.09		21	1.01		18.54		18	0.96			
XT7	20.73		20	1.00		18.82		16	1.03			
XT8	21.25		19	1.14		19.34		14	1.05			
XT9	21.98		20	1.27		20.24		13	0.84			
XT10	22.47		19	1.22		21.07		14	0.81			
XT11	22.85		21	1.18		21.51		17	1.10			
XT12	24.28		21	1.42		23.24		17	1.47			
XL1	26.08		23	1.49		25.35		19	1.44			
XL2	26.53		22	1.50		25.90		18	1.41			
XL3	27.34		22	1.36		26.26		19	1.04			
XL4	28.23		21	1.08		27.12		18	1.18			

LEDFORD LANDING, CONTINUED

Dimension	MALES						FEMALES					
	Mean		<i>n</i>		Std. Dev.		Mean		<i>n</i>		Std. Dev.	
	left	right			left	right	left	right			left	right
XL5	29.13		21		1.63		27.63		19		1.63	
S1	32.07		20		2.55		29.06		18		2.69	
SML	107.17		3		0.92		111.02		1			
HML	322.36	323.18	18	19	16.59	14.24	294.17	298.72	18	16	9.40	8.93
HEB	58.53	59.03	18	17	2.43	3.61	51.24	50.86	19	18	3.03	6.56
HHD	44.24	44.38	19	19	2.40	2.42	38.94	38.85	19	16	2.00	2.13
HMLD	20.33	20.80	18	18	1.72	1.17	17.75	17.89	19	16	1.55	1.23
HAPD	19.96	20.88	18	18	1.48	1.81	19.07	19.46	19	16	0.97	1.20
HAB	39.57	40.23	17	19	1.94	2.41	36.15	36.89	18	19	2.11	1.89
RML	250.41	251.44	17	18	10.81	9.77	223.33	228.18	18	17	6.41	5.14
RMLD	13.85	14.53	17	18	1.22	1.22	13.77	13.96	18	17	1.35	0.77
RAPD	11.86	11.75	17	18	1.43	0.96	10.59	10.72	18	17	0.76	0.63
RMLH	20.56	20.53	16	15	1.46	1.35	18.86	19.38	16	13	0.94	0.97
RAPH	21.43	21.23	15	15	1.20	1.37	19.63	19.93	16	13	1.07	1.08
RAB	23.90	24.05	15	17	1.68	0.94	22.73	22.87	19	16	1.40	1.37
UML	263.55	269.93	11	15	9.83	11.98	241.77	245.59	13	11	7.28	6.72
UMLD	12.82	13.20	11	15	1.76	0.77	11.35	11.77	13	11	1.01	0.84
UAPD	14.91	14.47	11	15	1.44	1.55	13.65	14.41	13	11	1.24	1.17
FML	449.48	447.42	21	18	17.04	17.16	412.07	411.70	21	20	11.14	12.60
FBL	446.74	444.25	21	18	16.80	17.22	407.69	407.63	21	20	11.15	12.57
FEB	78.60	78.33	20	18	3.16	3.00	71.34	71.71	19	17	3.44	3.15
FAB	68.89	69.19	20	20	3.19	3.06	62.10	62.09	20	19	2.99	2.70
FHD	44.14	44.23	23	21	1.91	2.17	39.56	39.62	22	22	1.81	1.80
FMLD	26.42	26.45	22	18	2.60	2.04	24.34	23.89	21	20	1.93	1.38
FAPD	29.27	28.66	22	18	1.73	2.41	25.17	25.05	21	20	1.93	2.09
TML	377.10	375.00	21	21	15.12	14.28	341.88	342.85	20	20	11.52	11.29
TFL	371.03	371.42	21	21	13.34	14.64	338.08	338.77	20	20	11.53	11.32
TPB	74.09	74.31	16	16	3.29	3.22	66.00	66.43	18	15	2.69	3.67
TPAB	71.87	72.29	16	16	2.92	3.05	64.25	64.50	19	15	3.32	2.71
TMLD	22.46	23.50	20	21	1.92	1.90	20.45	21.39	20	19	1.84	1.97
TAPD	28.38	28.54	20	21	1.54	2.59	24.86	25.07	20	19	2.66	2.54
FIML	365.29	359.92	7	6	15.46	11.32	329.33	328.60	6	5	7.00	9.96
BIB	269.73		13		12.95		259.32		11		14.90	
IBL	152.90	152.83	10	6	6.19	5.00	125.55	139.70	9	10	30.79	8.92
ACH	49.76	49.76	18	17	2.17	2.00	45.96	44.68	12	15	2.82	3.10
TCH	65.05	66.15	19	20	2.74	3.70	58.45	59.24	21	21	3.18	2.45
TTB	30.04	30.71	19	19	1.55	1.25	27.40	27.81	21	22	1.78	1.94

THOMPSON VILLAGE

Dimension	MALES						FEMALES					
	Mean		n	Std. Dev.		Mean		n	Std. Dev.			
	left	right		left	right	left	right		left	right		
BBH	142.83		6	3.31		136.43		7	4.20			
GBL	170.17		6	6.68		161.50		6	7.92			
EUB	147.83		6	4.88		139.14		7	4.56			
UFH	83.43		5	4.41		75.77		4	1.56			
NAH	28.09		3	1.30		27.96		2	0.18			
NAW	24.82		5	1.30		23.97		5	1.87			
ZYG	142.60		5	5.22		133.83		6	5.08			
JNB	30.78		6	2.63		26.05		10	1.53			
CML	149.32	148.60	11	10	8.44	7.62	138.44	137.50	9	11	8.64	8.60
CAPD	11.09	11.26	11	10	0.55	0.60	10.19	9.96	9	11	1.28	1.05
CSID	9.35	9.08	11	10	0.70	1.06	8.87	8.89	9	11	1.03	0.98
C1	10.62		7	0.88		9.69		9	1.02			
XC2	36.08		7	2.05		34.32		9	2.32			
XC3	12.73		7	1.82		12.15		9	1.05			
XC4	12.70		6	1.05		11.85		8	0.84			
XC5	12.75		8	0.61		11.73		9	0.98			
XC6	13.39		8	1.24		12.48		12	0.77			
XC7	14.82		8	1.28		14.00		12	0.68			
XT1	17.52		8	0.70		15.79		11	0.87			
XT2	18.09		10	0.84		17.17		11	1.08			
XT3	18.50		9	0.44		16.68		10	0.97			
XT4	18.87		7	0.66		17.18		10	0.85			
XT5	19.38		7	0.79		17.67		10	1.12			
XT6	20.37		7	0.82		19.08		10	0.97			
XT7	20.79		7	1.04		19.72		9	1.18			
XT8	21.19		7	1.12		20.13		9	1.36			
XT9	21.55		8	1.17		20.24		10	1.11			
XT10	22.12		9	0.77		21.17		10	1.02			
XT11	22.60		12	0.98		21.93		11	1.20			
XT12	24.47		12	1.18		23.74		11	1.98			
XL1	26.22		12	1.10		24.91		13	1.83			
XL2	26.47		11	1.25		25.95		13	1.39			
XL3	27.37		12	1.51		26.77		12	1.61			
XL4	28.22		12	1.67		27.48		13	1.73			

THOMPSON VILLAGE, CONTINUED

Dimension	MALES						FEMALES					
	Mean		n		Std. Dev.		Mean		n		Std. Dev.	
	left	right			left	right	left	right			left	right
XL5	28.27		12		0.89		27.71		13		1.82	
S1	30.96		11		1.15		29.41		13		1.79	
SML	113.37		4		7.95		108.07		4		2.23	
HML	312.55	315.36	11	11	11.27	8.14	295.04	297.00	13	11	14.49	12.24
HEB	58.77	59.50	11	11	3.33	3.29	53.54	54.50	12	10	1.97	1.99
HHD	45.36	44.95	10	11	2.26	2.70	39.49	39.87	13	12	1.97	1.48
HMLD	20.53	21.21	11	11	1.75	2.17	18.59	19.01	13	11	1.92	2.09
HAPD	20.24	20.80	11	11	1.75	1.16	20.35	20.09	13	11	2.04	2.18
HAB	42.26	42.65	10	10	2.30	1.81	38.27	37.77	12	10	1.75	1.59
RML	239.67	243.82	9	11	11.40	8.87	222.46	226.50	12	10	10.95	8.53
RMLD	14.20	14.62	10	11	1.32	1.34	14.33	14.31	12	10	1.51	1.83
RAPD	11.59	11.87	10	11	0.59	0.55	10.62	10.77	12	10	1.05	1.17
RMLH	20.58	20.63	9	12	0.76	1.02	18.55	18.86	10	10	1.12	0.93
RAPH	21.56	21.29	9	12	1.10	1.26	19.33	19.71	9	10	1.11	1.00
RAB	25.16	24.90	9	11	1.32	0.77	22.47	22.72	12	10	1.04	1.11
UML	258.78	261.35	9	10	11.38	10.10	237.95	243.33	10	9	15.06	8.89
UMLD	12.43	12.59	10	10	0.77	0.78	11.15	11.24	10	10	1.38	1.10
UAPD	15.14	16.13	10	10	1.52	1.24	14.47	14.80	10	10	1.67	1.43
FML	435.54	434.79	12	12	18.35	18.82	407.54	404.63	12	12	16.32	17.87
FBL	432.18	432.04	11	12	19.38	19.19	403.17	401.33	12	12	17.51	18.42
FEB	79.82	80.00	11	10	4.27	4.56	70.36	71.41	11	11	2.56	2.25
FAB	69.99	69.92	12	12	3.43	4.00	61.88	62.29	11	11	2.91	2.39
FHD	45.14	44.89	12	12	2.66	2.54	39.48	39.59	13	12	1.78	1.53
FMLD	25.79	25.71	12	12	1.58	1.97	24.91	23.91	13	12	1.94	1.69
FAPD	29.89	29.73	12	12	2.26	2.16	25.95	26.02	13	12	2.77	2.21
TML	362.67	363.88	12	12	14.54	14.61	337.10	335.27	10	11	18.89	18.20
TFL	358.08	358.62	12	12	13.55	13.68	332.75	331.29	10	11	18.97	18.32
TPB	75.10	74.60	10	10	3.41	3.20	66.86	67.75	7	10	2.14	1.65
TPAB	72.22	72.43	10	10	3.04	3.12	64.31	65.19	8	10	2.64	1.80
TMLD	22.17	23.17	12	12	1.42	1.62	19.05	21.54	10	12	1.52	1.94
TAPD	27.93	27.72	12	12	1.62	1.75	24.86	24.89	10	12	2.10	2.13
FIML	348.56	351.29	8	7	17.20	17.26	340.75	319.00	2	4	39.95	4.83
BIB	274.57		7		12.84		255.00		10		13.17	
IBL	154.20	153.33	5	6	7.73	5.89	140.70	141.38	10	8	9.52	10.14
ACH	50.85	49.66	10	11	3.21	2.71	45.66	46.00	13	11	2.19	1.95
TCH	64.55	65.90	10	10	4.04	3.92	57.71	58.44	7	8	2.20	3.10
TTB	30.37	30.52	10	10	1.41	1.80	27.24	26.84	7	9	0.90	0.87

TOQUA

Dimension	MALES						FEMALES					
	Mean		<i>n</i>	Std. Dev.		Mean		<i>n</i>	Std. Dev.			
	left	right		left	right	left	right		left	right		
BBH	138.00		14	5.64		134.92		12	5.84			
GBL	170.80		15	9.50		160.42		12	7.56			
EUB	146.42		12	10.97		145.83		12	12.80			
UFH	84.34		8	2.04		77.51		10	3.86			
NAH	24.88		8	2.16		25.29		10	2.81			
NAW	24.12		13	1.90		23.71		12	1.96			
ZYG	139.00		6	11.14		132.78		9	5.76			
JNB	25.89		11	3.33		22.46		11	2.34			
CML	150.23	148.25	15	18	9.30	9.43	139.50	138.25	15	12	7.03	6.97
CAPD	11.56	11.93	15	18	1.24	1.23	9.80	10.08	15	12	1.19	1.02
CSID	10.47	10.31	15	18	1.47	1.19	8.61	8.94	15	12	1.01	1.54
C1	10.96		13	1.15		9.63		16	0.78			
XC2	36.69		16	2.58		32.40		16	2.14			
XC3	13.38		15	1.28		12.24		15	1.11			
XC4	12.92		15	1.23		12.18		17	0.79			
XC5	12.77		16	1.20		11.93		18	0.81			
XC6	13.46		17	1.09		12.23		18	0.66			
XC7	15.05		16	0.86		13.74		18	0.76			
XT1	17.35		16	0.92		15.61		17	0.80			
XT2	18.53		16	1.07		16.95		18	0.91			
XT3	18.09		15	1.27		17.10		18	0.82			
XT4	18.52		15	0.84		17.62		18	0.70			
XT5	19.19		15	1.10		17.77		18	0.89			
XT6	19.65		15	1.00		18.70		18	0.71			
XT7	20.32		17	0.83		19.29		18	0.88			
XT8	21.07		17	0.97		19.66		18	0.73			
XT9	21.86		17	0.89		20.32		18	0.66			
XT10	22.45		16	1.08		20.98		18	0.77			
XT11	23.28		17	1.12		21.62		18	0.91			
XT12	25.32		17	1.35		23.86		18	1.04			
XL1	26.83		17	1.06		25.68		19	1.15			
XL2	27.67		15	1.61		26.14		19	1.23			
XL3	27.97		15	1.68		26.98		19	1.61			
XL4	28.89		15	1.60		27.66		19	1.49			

TOQUA, CONTINUED

Dimension	MALES						FEMALES					
	Mean		n		Std. Dev.		Mean		n		Std. Dev.	
	left	right			left	right	left	right			left	right
XL5	28.72		16		1.82		27.83		19		1.28	
S1	31.17		16		1.97		29.97		18		2.72	
SML	110.85		8		10.15		106.50		10		7.46	
HML	316.79	320.37	14	15	13.81	15.71	299.74	307.50	17	17	13.74	14.55
HEB	58.35	58.93	10	15	4.49	4.28	52.41	53.68	16	14	2.30	2.64
HHD	43.78	43.94	16	17	3.22	3.32	39.61	39.90	17	16	2.41	2.22
HMLD	20.49	21.28	14	17	1.95	1.88	18.49	18.67	17	17	2.03	2.07
HAPD	21.08	22.01	14	17	1.57	1.51	19.40	20.48	17	17	1.46	1.59
HAB	40.04	41.02	12	15	3.54	2.92	36.99	37.55	16	17	2.08	2.02
RML	242.57	244.61	14	9	10.95	8.89	231.04	230.56	13	18	14.67	12.67
RMLD	14.57	15.53	14	10	1.52	1.69	13.53	14.21	13	18	1.05	1.39
RAPD	12.29	12.76	14	10	1.06	1.14	11.08	10.99	13	18	0.91	0.91
RMLH	21.02	20.69	15	12	1.56	1.51	18.71	19.40	12	16	1.45	1.20
RAPH	21.58	21.58	15	11	1.54	1.36	19.77	20.11	12	16	1.22	0.99
RAB	24.75	24.55	13	11	2.18	2.37	22.66	23.32	15	18	1.07	1.57
UML	264.25	261.30	10	10	8.95	10.79	253.36	251.89	11	14	14.46	13.12
UMLD	13.44	13.53	10	10	1.10	1.24	12.56	11.96	11	14	1.57	1.66
UAPD	15.59	15.79	10	10	1.20	1.29	14.64	13.87	11	14	1.27	1.55
FML	441.42	440.94	18	17	17.08	16.40	421.53	422.71	16	17	23.00	24.57
FBL	438.11	437.97	18	17	16.86	16.13	417.91	418.65	16	17	22.50	24.31
FEB	77.92	77.59	12	11	6.13	7.16	70.81	71.17	13	15	4.09	4.07
FAB	68.44	68.24	13	12	5.47	6.46	62.65	62.46	12	15	3.86	3.24
FHD	44.62	44.53	17	18	2.85	2.98	40.41	40.49	18	19	1.81	2.37
FMLD	27.37	26.46	18	17	1.93	1.98	23.87	23.73	16	17	1.51	1.76
FAPD	28.69	28.68	18	17	2.73	2.51	25.96	26.33	16	17	2.65	2.85
TML	367.41	364.50	16	14	13.35	14.37	348.06	350.63	16	15	23.17	22.07
TFL	363.25	361.01	16	14	13.84	13.99	343.88	346.87	16	15	22.33	22.35
TPB	74.10	73.50	10	11	3.37	4.29	66.23	67.00	15	13	3.64	3.05
TPAB	72.19	71.80	9	11	2.36	4.08	64.80	65.55	15	13	3.80	3.13
TMLD	22.99	24.87	16	13	2.13	3.59	20.57	22.10	14	15	2.16	1.58
TAPD	30.52	28.74	16	13	2.65	2.87	25.20	24.58	14	15	2.58	2.49
FIML	346.33	355.10	3	5	4.73	11.70	338.17	338.29	6	7	22.33	22.27
BIB	271.91		11		12.94		261.54		13		16.22	
IBL	148.50	152.33	8	9	5.32	5.12	146.00	145.90	10	10	6.75	7.05
ACH	50.38	49.47	13	11	4.06	3.37	46.03	45.82	13	13	2.12	2.36
TCH	63.93	64.60	14	15	5.12	4.57	58.53	59.21	17	17	3.12	2.95
TTB	30.27	30.25	17	18	1.94	1.85	27.13	27.37	18	18	1.38	1.24

CAPLEN

Dimension	MALES						FEMALES					
	Mean		n	Std. Dev.		Mean		n	Std. Dev.			
	left	right		left	right	left	right		left	right		
BBH	136.29		7	6.32		136.00		4	5.23			
GBL	177.86		7	6.59		177.25		4	1.50			
EUB	139.29		7	4.39		136.25		4	2.22			
UFH	87.08		5	3.91		79.74		3	2.80			
NAH	29.34		4	3.45		25.90		2	0.53			
NAW	24.00		6	1.08		25.21		3	2.98			
ZYG	142.00		7	6.03		139.00		3	6.25			
JNB	29.74		2	0.16								
CML	155.67	150.75	3	4	8.62	9.00	143.75	139.00	4	2	6.85	12.73
CAPD	12.27	13.51	3	4	2.08	1.74	10.98	10.99	4	2	0.62	1.49
CSID	9.47	10.22	3	4	0.28	1.47	8.73	8.76	4	2	0.78	0.21
C1	10.75		2	0.41		10.23		4	1.87			
XC2	36.58		3	4.33		35.21		4	1.92			
XC3	11.92		3	0.70		12.19		4	0.57			
XC4	11.41		3	1.78		11.93		3	1.02			
XC5	11.78		3	0.36		10.96		4	1.37			
XC6	12.14		3	0.35		11.66		3	0.73			
XC7	13.84		3	0.79		12.84		3	1.17			
XT1	15.66		3	0.94		16.02		3	1.07			
XT2	16.61		4	0.99		16.35		2	1.42			
XT3	17.19		1			17.23		2	0.45			
XT4	17.47		1			17.84		1				
XT5	19.40		1			18.67		1				
XT6	19.11		2	0.98		19.50		1				
XT7	19.45		2	0.81		19.62		1				
XT8	19.89		2	0.77		19.98		2	0.33			
XT9	20.13		2	0.91		20.78		2	0.11			
XT10	21.17		2	0.54		21.58		2	0.11			
XT11	21.76		2	0.42		21.91		2	0.13			
XT12	23.63		2	0.64		23.62		3	0.31			
XL1	24.15		2	0.42		24.37		3	0.48			
XL2	24.83		2	0.52		24.30		3	0.76			
XL3	25.45		2	1.71		24.97		3	0.21			
XL4	26.29		2	1.50		26.02		3	1.06			

CAPLEN, CONTINUED

Dimension	MALES						FEMALES					
	Mean		n	Std. Dev.		Mean		n	Std. Dev.			
	left	right		left	right	left	right		left	right		
XL5	26.13		2		1.92		25.67		3		1.25	
S1	28.75		2		1.75		29.37		2		1.96	
SML							113.65		1			
HML	310.17	311.17	3	3	16.02	15.54	300.13	301.75	4	4	5.27	7.88
HEB	58.67	62.25	3	2	1.53	4.60	56.00	56.38	4	4	1.22	1.70
HHD	42.40	44.15	3	3	0.72	0.98	40.54	41.08	4	4	0.64	1.42
HMLD	20.86	23.11	3	3	2.10	0.35	18.43	18.83	4	4	1.57	1.15
HAPD	20.20	20.64	3	3	1.26	1.34	18.16	20.00	4	4	0.90	0.92
HAB	39.90	42.45	3	2	1.96	0.51	38.76	39.99	4	4	1.54	1.66
RML	251.17	250.17	3	3	14.11	15.46	230.63	232.50	4	2	5.96	7.78
RMLD	13.49	13.81	3	3	1.09	0.54	13.79	14.43	4	3	0.46	0.33
RAPD	12.29	12.68	3	3	0.48	0.19	10.94	10.95	4	3	1.22	1.43
RMLH	20.27	22.26	3	2	0.75	2.00	18.93	19.48	4	3	1.31	0.90
RAPH	21.10	21.56	2	3	0.32	0.78	19.36	19.11	4	3	1.86	0.49
RAB	25.50	26.23	3	3	2.79	2.27	23.16	23.53	2	2	1.36	1.99
UML	270.75	270.33	4	3	12.69	17.01	254.75	257.67	4	3	4.35	3.21
UMLD	12.84	13.75	4	3	0.97	0.55	11.20	11.11	4	4	0.56	0.49
UAPD	15.31	15.16	4	3	0.90	1.15	14.10	14.04	4	4	0.58	0.43
FML	434.50	438.00	4	2	16.71	25.46	421.63	422.00	4	3	5.25	7.94
FBL	429.75	450.00	4	1	14.77		417.63	415.33	4	3	3.90	7.09
FEB	78.50	83.00	2	1	0.71		72.83	71.67	3	3	0.76	0.58
FAB	68.86	69.40	4	1	1.71		60.75	62.20	4	3	2.53	2.23
FHD	43.56	43.40	4	3	2.42	3.01	39.78	39.70	4	4	0.47	1.18
FMLD	26.56	27.58	4	2	0.68	1.28	24.36	24.44	4	4	0.48	0.49
FAPD	29.35	29.26	4	2	0.16	1.61	27.01	27.01	4	4	0.71	1.00
TML	362.13	368.50	4	1	8.98		350.50	356.50	3	2	10.33	7.78
TFL	359.17	367.00	3	1	11.73		346.67	353.09	3	2	10.50	7.19
TPB	74.50	75.00	3	1	3.28		69.00	70.00	2	1	1.41	
TPAB	71.25	72.08	4	1	3.67		65.52	64.83	3	3	1.04	1.13
TMLD	21.68	24.33	4	1	1.58		19.49	20.77	2	3	0.13	2.40
TAPD	28.10	30.92	4	1	1.25		27.00	25.98	2	3	1.47	2.80
FIML	351.83	343.00	3	1	10.07		347.00	339.00	1	1		
BIB	267.50		2		3.54		264.00		1			
IBL	150.00	151.00	2	3	1.41	4.36	148.00	146.00	1	1		
ACH	51.08	50.69	2	2	0.99	1.78	45.45	45.39	2	2	0.72	0.30
TCH	66.17	68.00	3	2	1.61	0.00	60.33	61.00	3	3	2.08	1.73
TTB	30.18	29.71	3	2	0.99	0.64	26.72	26.62	3	3	0.23	0.21

ERNEST WHITTE AND FATE BELL SHELTER

Dimension	MALES						FEMALES					
	Mean		n	Std. Dev.		Mean		n	Std. Dev.			
	left	right		left	right	left	right		left	right		
BBH	130.00		1			138.67		3	2.89			
GBL	168.00		1			179.67		3	10.41			
EUB	137.00		1			130.00		3	3.46			
UFH						70.89		1				
NAH	27.40		1			28.39		1				
NAW	24.37		4	1.91		25.03		1				
ZYG						131.00		2	2.83			
JNB						28.23		1				
CML	160.33	154.67	3	3	13.32	9.02	154.00	125.00	1	1		
CAPD	12.81	13.53	3	3	1.49	2.16	11.85	8.98	1	1		
CSID	9.75	11.34	3	3	1.78	1.46	8.83	8.65	1	1		
C1	10.70		4	0.97								
XC2	36.53		4	2.62								
XC3	12.42		4	1.46								
XC4	13.01		2	1.34								
XC5	10.03		1			11.42		1				
XC6	13.22		3	0.81		12.09		4	0.85			
XC7	14.08		3	0.47		13.11		4	1.18			
XT1	15.52		4	0.39		15.25		3	0.48			
XT2	18.39		2	0.66		16.67		3	0.65			
XT3	18.72		2	0.18		17.05		3	1.01			
XT4	18.49		3	0.89		17.72		4	1.02			
XT5	19.21		2	0.41		19.05		3	0.83			
XT6	19.74		2	0.06		19.49		3	0.69			
XT7	20.69		2	0.71		20.01		3	0.81			
XT8	21.37		3	0.80		21.42		1				
XT9	21.46		2	1.58		21.79		1				
XT10	21.81		2	1.32		22.48		1				
XT11	23.15		3	0.77		22.69		2	2.06			
XT12	23.62		2	0.06		23.95		2	2.26			
XL1	25.75		3	0.74		25.21		2	2.45			
XL2	26.30		3	0.69		25.45		2	1.93			
XL3	27.15		2	0.40		25.88		3	1.63			
XL4	28.56		1			25.69		3	0.69			

ERNEST WHITTE AND FATE BELL SHELTER, CONTINUED

Dimension	MALES						FEMALES					
	Mean		n	Std. Dev.		Mean		n	Std. Dev.			
	left	right		left	right	left	right		left	right		
XL5	28.72		2	1.54		27.34		2	2.04			
S1	28.99		1			27.58		2	3.37			
SML						112.57		1				
HML	319.10	367.00	5	1	8.96		289.80	291.50	5	3	19.29	24.56
HEB	61.60	61.50	5	1	3.31		53.13	52.75	4	4	1.31	1.71
HHD	41.84		3		1.24		36.96	37.85	4	2	2.41	3.70
HMLD	20.10	25.83	5	1	2.30		16.90	16.11	5	3	2.24	2.16
HAPD	20.27	24.14	5	1	1.67		16.68	16.69	5	3	2.12	1.42
HAB	42.60	43.81	4	1	2.05		36.46	36.53	4	3	2.29	1.08
RML	248.70	261.50	5	4	11.72	17.86	231.33	227.50	3	3	10.97	13.94
RMLD	15.72	15.05	5	4	2.69	0.88	12.44	11.51	3	3	1.47	1.42
RAPD	14.43	12.69	5	4	3.72	0.91	9.72	9.30	3	3	1.50	0.64
RMLH	21.82	21.70	4	3	1.75	0.31	19.57	18.93	3	3	1.29	0.42
RAPH	22.17	21.32	4	3	1.28	1.19	19.79	19.09	3	3	1.09	0.20
RAB	24.49	26.75	3	4	0.60	1.32	22.44	22.72	3	3	1.05	0.39
UML	265.08	266.67	6	3	3.17	2.52	265.00	252.75	1	2		20.15
UMLD	13.63	14.97	6	3	1.69	1.26	9.92	10.44	1	2		0.30
UAPD	14.72	16.19	6	3	1.99	1.15	11.88	12.54	1	2		1.12
FML	452.25	463.00	4	1	27.40		424.00	400.50	2	2	36.77	6.36
FBL	451.50	460.00	2	1	47.38		419.50	399.00	2	2	37.48	5.66
FEB	82.75	82.00	2	1	10.25		73.17	70.00	3	1	9.54	
FAB	68.83	73.26	2	2	3.25	1.78	61.60	58.20	3	1	7.31	
FHD	46.92	47.28	5	4	2.37	3.06	39.67	36.80	2	1	4.83	
FMLD	28.40	27.34	4	2	2.18	0.18	21.51	21.63	1	1		
FAPD	30.60	31.52	4	2	1.42	2.48	24.69	24.58	1	1		
TML	373.00	363.00	3	3	17.52	13.89	334.00		1			
TFL	369.42	359.15	3	3	17.86	13.64	330.67		1			
TPB	76.00		1									
TPAB	75.24	77.35	1	1								
TMLD	23.53	24.73	3	3	1.74	0.86	18.54		1			
TAPD	29.42	32.02	3	3	1.21	1.41	22.41		1			
FIML												
BIB	244.00		1									
IBL	154.00	151.00	1	1								
ACH	53.60	51.83	1	1								
TCH	64.00	73.00	1	3		4.58	57.00	58.00	1	1		
TTB	30.93	32.19	4	6	1.18	1.10	27.32	28.09	1	1		

LOEVE FOX

Dimension	MALES						FEMALES					
	Mean		<i>n</i>	Std. Dev.		Mean		<i>n</i>	Std. Dev.			
	left	right		left	right	left	right		left	right		
BBH	139.60		10	4.25		131.29		7	3.64			
GBL	186.67		9	5.83		179.29		7	4.23			
EUB	131.00		10	4.19		123.71		7	3.30			
UFH	81.39		6	4.85		73.08		5	1.24			
NAH	28.69		2	1.97		23.94		2	0.76			
NAW	23.80		7	2.01		22.96		6	1.69			
ZYG	134.33		6	3.14		124.67		6	4.89			
JNB	27.29		5	1.77		25.66		4	1.50			
CML	151.42	150.56	6	8	8.55	9.25	140.83	142.13	6	4	5.23	6.49
CAPD	11.65	12.41	7	8	1.65	1.56	9.80	10.63	6	5	0.33	0.57
CSID	9.27	10.49	7	8	0.96	1.75	8.06	8.16	6	5	1.02	1.21
C1	11.27		9	0.93		10.44		6	1.38			
XC2	37.37		8	1.32		34.14		6	2.36			
XC3	12.29		8	1.18		10.44		6	1.13			
XC4	11.72		8	0.80		10.39		6	0.78			
XC5	12.03		8	0.93		10.39		7	1.35			
XC6	12.32		9	0.98		11.05		7	0.95			
XC7	14.01		8	0.94		12.67		7	0.63			
XT1	16.51		8	0.47		15.32		7	0.47			
XT2	17.99		10	1.04		16.95		7	0.60			
XT3	18.20		9	0.88		17.11		7	0.43			
XT4	19.22		8	0.69		17.42		7	0.46			
XT5	19.89		8	0.99		18.29		7	0.78			
XT6	20.16		9	1.37		19.19		7	0.67			
XT7	21.42		7	1.19		19.63		7	0.36			
XT8	21.93		7	1.46		20.12		7	0.50			
XT9	22.62		8	1.10		20.45		7	0.41			
XT10	23.08		9	0.89		21.25		6	0.47			
XT11	23.75		11	1.04		21.93		7	0.71			
XT12	25.22		11	1.19		23.79		6	1.08			
XL1	26.29		11	1.51		24.91		7	1.21			
XL2	26.19		10	1.20		24.88		7	1.62			
XL3	26.71		10	1.18		25.60		7	1.50			
XL4	27.70		10	1.36		27.01		6	0.91			

LOEVE FOX, CONTINUED

Dimension	MALES						FEMALES					
	Mean		<i>n</i>		Std. Dev.		Mean		<i>n</i>		Std. Dev.	
	left	right			left	right	left	right			left	right
XL5	28.07		10		1.10		27.81		6		1.53	
S1	30.06		11		1.48		29.00		7		2.10	
SML	117.09		8		10.82		105.29		3		4.19	
HML	325.33	325.35	6	10	10.43	13.04	305.92	307.33	6	6	12.03	8.84
HEB	61.50	62.30	8	10	1.83	2.36	53.21	53.00	7	5	3.17	1.54
HHD	45.20	45.92	9	9	2.01	1.84	38.79	39.73	5	7	0.87	0.94
HMLD	20.25	20.96	6	11	1.56	1.80	18.39	17.67	6	6	1.64	1.81
HAPD	19.94	21.16	6	11	1.79	1.18	16.57	17.65	6	6	1.07	0.81
HAB	41.99	42.29	7	10	0.98	1.15	38.10	37.55	7	5	1.99	1.11
RML	255.72	257.75	9	8	7.30	8.08	234.90	234.25	5	6	16.48	7.25
RMLD	14.03	14.66	9	8	1.46	1.26	12.78	12.52	6	6	1.72	1.18
RAPD	11.84	11.90	9	8	0.74	0.62	10.67	10.34	6	6	0.82	0.80
RMLH	22.37	22.32	9	8	0.81	1.09	19.72	19.86	6	6	0.92	0.60
RAPH	23.02	22.98	9	8	0.90	0.99	20.92	20.24	6	6	1.49	0.79
RAB	25.78	26.40	6	8	1.48	1.48	23.01	22.96	6	5	1.24	1.16
UML	276.00	277.36	7	7	6.87	12.72	251.40	250.90	5	5	14.26	9.79
UMLD	12.66	13.56	7	8	1.22	1.20	12.78	11.44	6	5	1.41	0.44
UAPD	14.37	14.76	7	8	1.18	1.08	13.85	13.09	6	5	0.58	0.99
FML	455.33	455.17	9	9	18.35	19.85	431.25	431.67	6	6	13.21	10.44
FBL	451.22	451.28	9	9	18.53	19.85	427.08	427.60	6	5	13.27	11.12
FEB	80.39	81.78	9	9	3.05	2.84	70.40	71.00	5	4	2.53	2.48
FAB	71.47	71.64	9	10	1.57	3.88	61.61	63.10	6	7	3.85	3.09
FHD	44.79	45.09	10	11	1.70	1.54	40.19	40.56	6	6	1.52	1.29
FMLD	25.86	25.50	10	10	2.25	2.23	23.23	23.86	6	7	1.78	1.81
FAPD	28.75	30.75	10	10	1.65	1.37	25.91	25.60	6	7	0.98	0.52
TML	385.13	387.25	8	10	18.42	16.35	370.40	362.13	5	4	9.74	12.66
TFL	381.75	384.25	8	10	18.31	16.28	366.80	357.88	5	4	9.42	11.74
TPB	78.14	77.33	7	9	2.88	3.70	67.60	68.17	5	6	2.19	3.08
TPAB	74.96	74.68	7	9	2.62	3.26	65.00	66.63	6	6	2.22	1.84
TMLD	21.94	23.88	8	10	1.37	2.10	19.93	20.27	6	6	1.44	0.87
TAPD	29.68	30.78	8	10	2.98	2.99	25.75	25.23	6	6	1.01	1.65
FIML	379.58	375.75	6	2	15.31	11.67	341.00	351.50	1	2		14.85
BIB	267.25		8		13.79		265.25		6		10.33	
IBL	152.13	152.60	8	5	6.79	7.73	146.00	145.40	6	5	5.44	7.02
ACH	49.38	50.58	9	9	2.16	2.20	45.23	46.05	7	4	1.55	1.67
TCH	66.21	67.92	7	6	2.60	3.47	55.25	58.13	2	4	0.35	2.17
TTB	30.76	30.76	9	8	1.19	0.76	27.12	27.11	4	4	2.26	1.33

MITCHELL RIDGE

Dimension	MALES						FEMALES					
	Mean		n	Std. Dev.		Mean		n	Std. Dev.			
	left	right		left	right	left	right		left	right		
BBH	142.10		10	5.76		135.80		5	4.76			
GBL	180.20		10	6.48		173.33		6	6.44			
EUB	138.30		10	5.27		136.00		6	3.03			
UFH	84.39		10	6.29		77.57		5	1.53			
NAH	28.19		8	3.05		26.95		5	1.98			
NAW	25.23		9	1.99		25.04		7	1.83			
ZYG	138.60		10	7.11		131.40		5	5.94			
JNB	28.93		6	4.31		23.73		3	0.44			
CML	153.88	151.65	8	10	7.16	7.13	141.17	137.79	6	7	5.16	8.10
CAPD	12.64	13.01	9	9	1.66	1.69	10.48	10.69	6	7	1.01	1.50
CSID	10.07	10.65	9	9	1.43	1.55	8.37	8.70	6	7	0.52	0.59
C1	10.67		9	1.18		9.98		6	0.81			
XC2	37.08		10	3.63		33.99		6	3.15			
XC3	13.03		10	1.40		11.50		5	1.20			
XC4	13.37		8	1.65		11.58		5	1.22			
XC5	12.71		9	1.35		11.40		7	1.28			
XC6	12.87		9	1.33		11.60		7	1.36			
XC7	14.26		8	1.04		13.24		7	0.92			
XT1	16.38		8	1.14		15.20		7	0.57			
XT2	18.30		9	0.80		16.76		7	0.87			
XT3	18.48		8	1.14		16.56		7	1.14			
XT4	19.16		8	1.06		17.02		7	0.73			
XT5	19.87		7	0.79		17.81		7	0.99			
XT6	20.05		7	1.00		18.43		6	0.87			
XT7	20.76		7	1.21		18.94		6	0.89			
XT8	21.27		7	0.63		19.54		7	0.77			
XT9	21.86		7	0.94		19.91		6	1.21			
XT10	22.08		7	1.05		21.13		6	1.04			
XT11	22.84		8	0.95		22.25		6	1.16			
XT12	24.40		8	1.32		24.70		6	1.40			
XL1	25.76		9	1.26		25.41		7	1.86			
XL2	25.81		9	0.84		26.05		8	1.56			
XL3	26.54		10	1.04		26.94		8	1.57			
XL4	27.58		9	0.95		27.31		8	1.05			

MITCHELL RIDGE, CONTINUED

Dimension	MALES						FEMALES					
	Mean		<i>n</i>		Std. Dev.		Mean		<i>n</i>		Std. Dev.	
	left	right			left	right	left	right			left	right
XL5	28.33		9		0.95		28.09		8		0.95	
S1	30.73		8		2.58		29.00		6		2.47	
SML	117.15		6		3.56		111.55		5		4.00	
HML	318.19	318.14	8	7	15.20	12.27	299.00	299.13	6	8	4.70	6.62
HEB	60.30	61.25	10	10	3.47	3.65	54.36	55.78	7	9	1.21	3.73
HHD	44.61	44.82	9	10	3.62	2.93	41.13	39.61	6	7	2.70	1.43
HMLD	21.96	23.02	9	7	3.22	3.38	19.45	19.55	7	8	1.26	1.22
HAPD	21.69	22.41	9	7	2.49	2.89	18.26	19.42	7	8	.90	1.06
HAB	43.08	43.03	10	10	2.93	3.53	38.96	39.24	6	8	2.38	3.08
RML	251.61	253.17	9	9	14.24	11.61	233.50	239.44	8	8	4.67	11.69
RMLD	14.92	15.22	9	9	1.49	1.20	13.05	13.71	8	8	1.22	0.93
RAPD	12.47	12.43	9	9	1.06	1.17	10.52	10.77	8	8	0.46	0.54
RMLH	21.33	21.37	9	9	1.67	1.30	19.32	20.14	7	8	0.93	1.91
RAPH	22.34	22.36	9	9	1.80	1.83	20.02	20.52	7	8	0.75	1.53
RAB	25.57	25.85	9	8	1.93	1.35	23.55	23.61	8	9	1.94	2.03
UML	271.85	272.55	10	10	12.87	12.36	252.93	259.44	7	8	4.80	11.94
UMLD	13.54	13.62	10	10	1.34	1.54	11.47	12.88	7	8	1.06	1.96
UAPD	15.89	16.65	10	10	1.46	2.23	14.25	14.87	7	8	0.74	1.58
FML	456.00	455.50	10	10	17.10	18.39	423.67	419.36	6	7	10.29	11.48
FBL	452.60	451.65	10	10	17.74	19.31	418.08	414.20	6	5	10.02	10.57
FEB	82.00	82.50	9	9	4.92	5.01	72.20	70.50	5	3	2.77	0.50
FAB	72.29	72.77	10	9	4.70	5.32	60.88	58.87	6	4	2.91	1.99
FHD	45.16	45.27	10	10	3.05	2.95	40.81	40.40	7	9	2.37	2.40
FMLD	27.00	26.97	9	10	2.16	1.91	24.36	24.97	7	9	0.88	1.88
FAPD	32.25	32.06	9	10	3.02	3.29	26.66	27.50	7	9	1.19	1.93
TML	391.79	389.67	7	9	17.60	17.58	350.81	353.13	8	4	11.37	11.27
TFL	387.36	385.72	7	9	16.93	17.60	347.82	349.54	8	4	10.85	10.87
TPB	77.38	77.06	8	9	4.99	4.48	68.25	67.50	6	3	2.60	2.18
TPAB	75.15	75.27	8	9	5.44	4.96	65.57	64.84	6	3	2.99	1.69
TMLD	22.88	24.63	8	8	1.83	1.66	19.64	20.29	8	4	2.93	1.47
TAPD	28.83	30.90	8	8	4.02	1.90	25.64	25.47	8	4	2.98	2.34
FIML	362.20	348.00	5	4	36.36	32.46	340.50	338.83	5	3	9.10	8.89
BIB	281.75		8		13.91		258.80		5		6.38	
IBL	158.56	159.63	9	8	7.92	8.62	144.50	149.17	6	6	5.54	9.17
ACH	50.27	50.14	9	9	3.07	3.52	45.32	46.39	6	7	2.02	3.38
TCH	66.00	67.67	7	9	4.20	3.70	58.40	59.29	5	7	2.77	2.31
TTB	30.80	30.80	9	9	2.27	2.28	26.60	26.61	6	7	1.95	1.71

CALDWELL VILLAGE

Dimension	MALES						FEMALES					
	Mean		n	Std. Dev.		Mean		n	Std. Dev.			
	left	right		left	right	left	right		left	right		
BBH	133.00		3	9.54		124.00		3	7.00			
GBL	168.33		3	8.50		154.67		3	9.07			
EUB	152.00		3	14.53		142.67		3	10.02			
UFH	80.61		3	3.29		72.13		3	5.30			
NAH	26.90		3	1.43		25.56		3	.89			
NAW	24.15		3	0.83		24.55		3	2.09			
ZYG	138.00		3	12.29		127.00		3	7.94			
JNB	28.15		3	3.02		27.21		2	3.45			
CML	151.38	145.83	4	3	12.06	10.52	130.83	130.17	3	3	1.89	2.52
CAPD	10.56	10.59	4	3	1.34	0.90	9.37	9.25	3	3	1.26	.51
CSID	8.71	10.13	4	3	1.57	0.99	7.59	7.35	3	3	0.64	0.29
C1	9.94		3	1.34		11.42		3	2.15			
XC2	34.75		5	2.40		30.35		3	4.31			
XC3	12.46		5	0.56		12.08		3	0.75			
XC4	12.37		4	0.52		11.77		3	0.63			
XC5	12.12		4	0.48		10.95		4	0.40			
XC6	12.33		4	0.28		11.34		4	0.37			
XC7	13.68		4	0.72		12.76		4	0.31			
XT1	16.33		5	0.78		14.56		4	0.78			
XT2	17.86		5	0.94		15.89		4	0.35			
XT3	18.05		4	1.75		15.85		4	0.37			
XT4	17.86		4	0.82		16.32		4	0.41			
XT5	19.00		4	1.03		17.01		4	0.45			
XT6	19.99		4	1.32		17.66		4	0.43			
XT7	20.36		4	1.32		17.81		4	0.75			
XT8	21.06		4	1.51		18.18		4	0.98			
XT9	21.63		4	1.32		18.18		4	1.11			
XT10	22.78		5	1.39		19.67		3	0.03			
XT11	23.30		3	2.08		20.68		2	0.46			
XT12	25.40		3	2.12		22.25		3	0.91			
XL1	26.82		3	1.38		23.50		4	0.91			
XL2	27.25		4	1.02		24.01		4	1.21			
XL3	27.87		2	1.21		24.14		3	1.48			
XL4	28.37		2	1.22		23.70		1				

CALDWELL VILLAGE, CONTINUED

Dimension	MALES						FEMALES					
	Mean		n	Std. Dev.		Mean		n	Std. Dev.			
	left	right		left	right	left	right		left	right		
XL5	28.55		2	2.69		26.11		4	1.06			
S1	31.71		3	2.22		27.18		4	2.00			
SML	105.36		2	7.12		117.53		3	6.04			
HML	309.80	304.50	5	4	17.22	19.30	285.00	287.33	2	3	9.90	6.66
HEB	57.10	56.50	5	4	3.78	2.52	51.50	50.83	2	3	2.12	1.53
HHD	42.39	41.36	5	4	3.58	2.86	37.65	38.01	2	4	0.42	0.51
HMLD	20.53	20.71	4	5	2.25	2.57	18.48	18.05	2	3	0.86	0.71
HAPD	18.71	19.39	4	5	3.24	3.17	14.56	15.66	2	3	1.72	1.16
HAB	42.28	40.09	5	4	3.55	3.64	38.44	37.04	2	3	0.84	0.87
RML	239.00	239.70	3	5	18.08	12.62	211.50	212.83	3	3	7.55	8.61
RMLD	12.82	13.51	3	5	1.80	1.81	11.28	11.68	3	3	0.55	0.50
RAPD	10.23	10.82	3	5	1.61	1.44	9.12	9.25	3	3	1.19	0.86
RMLH	20.78	20.68	3	4	2.19	2.11	18.94	18.72	3	3	0.54	0.69
RAPH	20.97	21.27	2	4	3.67	2.71	19.70	18.98	3	3	0.91	0.58
RAB	24.23	24.53	4	5	2.41	1.24	22.62	21.71	3	3	0.84	0.49
UML	253.50	252.63	3	4	12.82	11.61	231.50	233.50	3	3	5.22	7.47
UMLD	11.78	11.05	3	4	1.50	2.22	9.93	9.58	3	3	0.60	0.58
UAPD	13.46	12.93	3	4	1.63	1.26	11.00	11.95	3	3	1.13	0.28
FML		419.50		3		33.01		379.88		4		13.19
FBL		416.67		3		33.08		375.63		4		10.92
FEB	75.33	75.50	3	3	8.10	7.81	67.38	68.25	4	4	2.14	1.19
FAB	65.64	65.10	3	3	6.82	6.48	59.45	59.84	4	4	2.39	1.11
FHD	40.81	41.61	3	3	4.14	3.53	37.17	38.12	4	4	1.25	0.98
FMLD	25.74	24.89	1	3		3.05		22.59		4		2.10
FAPD	30.35	26.49	1	3		5.04		22.22		4		1.48
TML	355.67	356.00	3	3	29.14	29.96	317.83	315.00	3	3	6.05	6.00
TFL	351.95	352.17	3	3	28.62	29.54	315.01	312.17	3	3	6.18	7.29
TPB	71.33	71.67	3	3	7.37	7.77	64.63	65.25	4	4	2.50	3.23
TPAB	69.99	68.57	3	3	8.11	7.43	63.58	63.57	4	4	2.21	2.37
TMLD	22.17	23.38	3	3	4.05	3.73	17.08	19.27	3	3	1.70	2.55
TAPD	28.51	27.60	3	3	5.70	4.68	23.04	22.30	3	3	0.80	0.86
FIML	331.00	351.38	2	4	12.73	27.03	309.25	307.75	4	4	7.27	10.21
BIB	256.50		2		19.09		251.50		4		15.42	
IBL	148.50	147.50	2	2	7.78	7.78	137.50	139.50	4	2	7.59	12.02
ACH	48.10	47.57	3	3	4.41	3.70	44.22	43.49	4	4	1.47	.91
TCH	57.75	60.50	2	3	6.72	4.92	54.50	55.13	4	4	1.47	1.31
TTB	27.84	27.80	3	2	2.74	2.57	26.17	26.39	4	4	0.75	1.67

DUNA LEYENDA

Dimension	MALES						FEMALES					
	Mean		n	Std. Dev.		Mean		n	Std. Dev.			
	left	right		left	right	left	right		left	right		
BBH	134.00		4	3.74		128.50		2	7.78			
GBL	176.50		4	4.65		175.50		2	3.54			
EUB	133.00		4	7.75		130.50		2	4.95			
UFH	80.12		4	3.22		75.21		2	3.57			
NAH	30.83		3	0.68		25.50		2	2.49			
NAW	25.99		4	1.10		23.56		2	0.53			
ZYG	135.50		4	4.80		124.50		2	2.12			
JNB	31.14		2	2.02		26.76		1				
CML	155.00	143.67	2	3	5.66	13.80	123.25	120.25	2	2	6.01	1.77
CAPD	11.39	11.67	2	3	1.01	1.48	10.34	10.77	2	2	1.10	1.00
CSID	8.93	8.80	2	3	0.16	0.99	7.46	8.40	2	2	0.32	0.08
C1	10.54		2	0.32		10.07		2	0.59			
XC2	34.92		2	3.71		32.20		2	0.54			
XC3	11.54		1			11.52		2	0.25			
XC4	10.98		1			11.61		2	0.01			
XC5	11.95		1			11.18		2	0.03			
XC6	11.93		2	1.71		11.55		2	0.67			
XC7	12.97		2	1.56		13.30		2	0.43			
XT1	14.38		2	0.58		15.32		2	0.57			
XT2	16.48		2	1.36		14.99		2	2.41			
XT3	16.76		2	2.81		16.09		2	0.81			
XT4	16.81		2	1.92		15.98		2	0.64			
XT5	17.24		2	1.77		16.78		2	0.25			
XT6	17.78		2	1.99		17.11		2	0.34			
XT7	20.12		1			18.10		2	0.55			
XT8	20.91		1			18.49		2	0.19			
XT9	20.76		1			19.14		2	0.31			
XT10	21.31		2	2.25		20.01		2	0.34			
XT11	21.51		2	2.89		20.85		2	1.12			
XT12	23.73		2	3.83		21.82		2	0.09			
XL1	24.93		2	2.38		23.90		2	0.47			
XL2	25.72		2	2.37		24.86		2	1.43			
XL3	27.06		2	2.60		26.38		2	0.75			
XL4	29.08		1			26.05		2	1.17			

DUNA LEYENDA, CONTINUED

Dimension	MALES						FEMALES					
	Mean		n	Std. Dev.		Mean		n	Std. Dev.			
	left	right		left	right	left	right		left	right		
XL5	31.44		1			26.41		2	0.62			
S1	31.50		2	0.94		28.66		2	0.26			
SML	106.08		1			108.24		1				
HML	307.50	302.50	2	2	3.54	14.85	270.00	273.50	2	2	11.31	13.44
HEB	57.00	58.50	3	2	7.55	2.12	53.00	51.50	1	1		
HHD	42.56	43.66	2	2	3.32	4.94	37.88	38.24	1	2		0.95
HMLD	21.78	20.96	3	2	1.72	3.32	19.42	18.93	2	2	1.80	0.01
HAPD	18.51	20.27	3	2	1.68	0.19	19.11	18.97	2	2	.21	2.02
HAB	40.24	40.98	3	2	2.63	1.60	39.33	38.24	1	1		
RML	233.50	232.75	3	2	11.95	10.96	204.75	205.25	2	2	5.30	5.30
RMLD	13.23	13.38	3	3	1.60	1.01	12.17	12.12	2	2	1.08	1.03
RAPD	11.14	11.11	3	3	0.43	0.52	11.84	12.01	2	2	0.08	0.95
RMLH	20.24	20.45	2	2	2.47	1.86	17.14	17.82	2	2	1.01	0.01
RAPH	20.78	20.57	2	2	1.99	2.11	18.18	18.02	2	2	0.78	0.64
RAB	24.84	24.78	2	3	0.94	1.15	21.69	21.91	2	2	0.95	0.28
UML	248.00	245.00	2	2	15.56	9.90	221.00	221.75	1	2		2.47
UMLD	11.89	11.95	2	2	1.10	0.35	10.49	11.63	1	2		1.46
UAPD	15.78	15.58	2	2	2.39	0.86	13.94	12.02	1	2		0.65
FML	414.50	423.50	2	2	20.51	2.12	377.75	376.75	2	2	18.74	13.79
FBL	411.00	417.25	2	2	18.38	5.30	372.25	372.25	2	2	18.74	15.20
FEB	73.75	76.00	2	3	1.06	2.65	67.25	68.00	2	1	0.35	
FAB	66.49	66.59	2	3	4.10	2.92	58.48	60.00	2	2	0.48	0.12
FHD	43.75	43.77	3	3	1.93	2.54	39.17	39.29	2	2	0.78	0.30
FMLD	26.60	27.66	3	2	0.57	1.29	25.47	25.82	2	2	1.68	3.00
FAPD	27.91	27.02	3	2	1.16	0.70	23.89	23.95	2	2	2.39	0.22
TML	348.67	347.00	3	3	13.80	14.11	319.75	318.25	2	2	7.42	5.30
TFL	345.31	345.24	3	3	13.69	15.33	315.92	314.95	2	2	8.37	5.58
TPB	77.00	73.50	1	2		3.54	64.25	65.00	2	2	0.35	0.00
TPAB	68.28	70.51	1	2		2.38	61.31	63.53	2	2	0.32	0.15
TMLD	20.58	24.00	3	3	1.44	2.01	18.20	22.80	1	2		0.51
TAPD	29.20	27.11	3	3	2.34	1.62	25.18	26.72	1	2		3.17
FIML	349.00	341.50	2	3	2.83	14.40	300.00	302.00	1	1		
BIB	267.75		2	1.77		255.50		2	7.78			
IBL	152.00	149.00	1	1			135.00	134.00	2	1	1.41	
ACH	49.68	48.06	2	3	0.05	2.06	44.51	44.61	2	2	0.99	0.04
TCH	63.50	66.00	2	1	0.71		61.00	57.50	1	2		0.71
TTB	27.54	27.81	3	3	0.88	0.43	25.52	26.20	2	2	0.35	0.75

EVANS AND PAROGONAH MOUNDS

Dimension	MALES						FEMALES					
	Mean		n	Std. Dev.		Mean		n	Std. Dev.			
	left	right		left	right	left	right		left	right		
BBH	134.40		5	4.72		124.67		3	4.73			
GBL	172.00		5	5.24		158.67		3	6.66			
EUB	150.20		5	10.28		142.33		3	2.52			
UFH	80.54		5	3.11		74.15		3	2.59			
NAH	28.37		5	1.87		25.52		3	2.22			
NAW	26.19		5	1.65		25.85		3	0.64			
ZYG	139.40		5	5.50		132.00		3	2.00			
JNB	25.38		3	1.90		26.41		1				
CML	147.50	144.75	3	2	7.86	9.55	132.83	132.00	3	2	4.65	1.41
CAPD	11.13	12.32	3	2	1.64	1.45	9.17	9.27	4	2	0.56	0.01
CSID	10.38	10.41	3	2	0.34	0.20	9.03	9.57	4	2	0.58	0.76
C1	11.80		3	0.51		10.51		2	1.56			
XC2	37.20		2	1.53		33.05		4	1.99			
XC3	14.07		2	1.20		11.27		4	0.70			
XC4	13.12		2	0.94		11.25		3	0.10			
XC5	12.98		2	0.16		10.99		3	0.82			
XC6	12.15		3	0.48		11.59		4	0.86			
XC7	14.05		3	1.00		12.97		4	0.66			
XT1	16.06		3	1.09		14.70		4	0.66			
XT2	18.15		3	0.64		16.62		4	0.70			
XT3	18.39		3	0.63		16.34		4	0.76			
XT4	19.67		3	0.90		16.93		4	0.69			
XT5	20.45		3	1.03		17.53		4	0.55			
XT6	21.27		3	1.96		17.94		4	0.77			
XT7	21.18		3	1.07		18.30		4	0.75			
XT8	21.83		3	0.31		18.97		2	1.12			
XT9	22.92		3	1.16		19.77		2	0.75			
XT10	23.32		3	1.45		20.08		2	1.07			
XT11	23.30		3	1.47		20.61		2	0.13			
XT12	25.00		3	0.91		22.12		2	0.34			
XL1	26.24		3	1.44		24.47		3	1.15			
XL2	25.96		3	1.80		25.37		3	0.67			
XL3	27.16		3	1.31		24.90		3	0.41			
XL4	27.77		3	1.21		25.82		4	0.72			

EVANS AND PAROGONAH MOUNDS, CONTINUED

Dimension	MALES						FEMALES					
	Mean		n	Std. Dev.		Mean		n	Std. Dev.			
	left	right		left	right	left	right		left	right		
XL5	28.84		3	0.76		26.07		4	0.77			
S1	31.99		3	0.66		27.45		4	1.13			
SML	113.00		3	5.87		105.86		4	9.97			
HML	299.75	297.75	2	2	6.72	5.30	298.00	267.00	1	1		
HEB	60.00	60.67	2	3	3.54	3.40	52.00	47.00	1	1		
HHD	44.02	44.00	2	3	1.34	1.08	39.23	38.40	1	2		4.32
HMLD	20.43	21.87	2	2	1.65	0.85	19.81	17.96	1	1		
HAPD	19.61	19.94	2	2	0.47	0.75	17.07	16.85	1	1		
HAB	44.89	43.54	2	3	1.11	1.79	40.83	34.93	1	1		
RML	241.50	242.88	4	4	2.04	0.85	219.50	214.33	3	3	8.23	9.83
RMLD	13.79	14.24	4	4	1.94	2.18	13.62	12.76	3	3	0.78	2.07
RAPD	11.52	11.35	4	4	1.29	0.88	10.35	9.41	3	3	0.79	0.77
RMLH	20.74	21.59	4	4	1.04	1.41	19.16	19.03	4	3	2.09	1.61
RAPH	21.77	21.66	4	4	1.05	1.30	19.70	19.29	4	3	1.76	1.80
RAB	25.53	25.10	4	4	1.45	0.92	23.93	23.15	3	3	1.25	2.13
UML	261.38	262.50	4	4	2.98	4.14	235.33	231.75	3	2	8.08	3.18
UMLD	12.12	12.72	4	4	1.48	1.07	10.81	11.14	3	2	0.92	0.69
UAPD	13.16	13.76	4	4	1.78	1.53	11.90	11.15	3	2	1.60	1.37
FML	416.00	417.17	1	3		3.33	403.50		1			
FBL	411.00	413.33	1	3		4.04	400.00		1			
FEB	77.75	78.83	2	3	1.77	2.02	69.00		2		5.66	
FAB	69.92	69.87	2	3	3.24	2.07	62.61		2		4.29	
FHD	44.08	44.41	3	3	1.07	1.82	39.92		1			
FMLD	26.10	24.59	2	3	2.98	3.31	23.53		1			
FAPD	28.67	28.26	2	3	2.82	2.76	26.64		1			
TML	341.50	350.67	1	3		8.61	337.50	341.00	1	1		
TFL	339.00	347.93	1	3		9.02	334.50	337.55	1	1		
TPB	74.75	74.75	2	2	0.35	2.47	66.50	67.50	1	1		
TPAB	72.51	72.32	2	2	0.68	2.85	65.96	66.34	1	1		
TMLD	21.95	24.68	1	3		1.94	20.30	18.16	1	1		
TAPD	29.23	29.57	1	3		2.66	26.88	22.54	1	1		
FIML	337.50	335.25	2	2	10.61	8.84	317.13	316.17	4	3	12.76	13.05
BIB	263.00		3		5.89		265.00		4		12.19	
IBL	148.33	150.00	3	3	4.04	3.61	150.50	145.00	4	2	9.15	4.24
ACH	48.57	48.96	3	4	1.19	1.57	44.93	44.71	4	3	3.81	3.99
TCH	65.00	66.00	3	3	2.65	3.61	58.50	60.00	2	1	0.71	
TTB	30.26	30.08	3	3	1.57	0.78	27.63	27.92	2	1	0.81	

GLEN CANYON

Dimension	MALES						FEMALES					
	Mean		n	Std. Dev.		Mean		n	Std. Dev.			
	left	right		left	right	left	right		left	right		
BBH	133.58		31	4.21		129.81		21	5.67			
GBL	173.87		31	9.91		168.05		21	8.62			
EUB	137.76		29	8.14		135.68		19	8.70			
UFH	81.09		34	4.76		76.34		20	4.85			
NAH	28.32		32	2.66		25.92		19	2.19			
NAW	24.81		35	1.56		23.86		21	1.27			
ZYG	136.85		33	6.22		129.00		19	6.27			
JNB	25.55		23	3.11		23.11		15	2.83			
CML	151.89	150.68	27	28	6.42	6.52	138.28	136.23	23	24	5.54	6.05
CAPD	10.90	11.47	27	28	1.27	1.05	9.42	9.61	24	24	1.07	0.78
CSID	9.15	9.39	27	28	1.03	0.87	7.97	8.12	24	24	1.00	1.06
C1	10.88		24	1.34		10.09		22	1.11			
XC2	35.50		26	2.11		32.85		24	1.75			
XC3	13.09		26	1.11		12.20		24	0.94			
XC4	12.65		25	0.85		11.83		22	0.92			
XC5	12.44		26	0.94		11.66		22	0.85			
XC6	12.49		29	0.91		11.59		22	1.06			
XC7	13.91		28	0.80		12.81		22	1.14			
XT1	15.94		27	0.91		15.04		22	0.97			
XT2	17.38		30	1.06		16.45		23	1.11			
XT3	17.54		27	1.09		16.50		22	1.10			
XT4	18.28		29	1.04		17.00		22	1.01			
XT5	18.91		31	1.26		17.55		21	1.18			
XT6	19.63		31	1.16		18.12		21	1.43			
XT7	20.14		31	1.04		18.32		21	1.51			
XT8	20.89		30	1.33		19.02		19	1.54			
XT9	21.61		33	1.33		19.66		19	1.43			
XT10	22.41		32	1.40		20.52		19	1.53			
XT11	22.93		34	1.53		21.07		18	1.47			
XT12	24.50		32	1.84		22.51		18	1.68			
XL1	25.90		33	1.65		24.48		23	1.45			
XL2	26.32		34	1.57		25.24		25	1.26			
XL3	27.54		36	1.63		25.96		25	1.26			
XL4	28.39		37	1.43		26.52		25	1.40			

GLEN CANYON, CONTINUED

Dimension	MALES						FEMALES					
	Mean		n		Std. Dev.		Mean		n		Std. Dev.	
	left	right			left	right	left	right			left	right
XL5	28.68		38		1.73		27.68		26		1.67	
S1	30.20		35		2.13		28.44		29		2.09	
SML	108.55		27		9.26		105.86		20		10.90	
HML	312.42	311.05	30	30	10.86	11.61	289.69	291.02	26	25	9.86	8.15
HEB	59.40	59.31	29	32	2.89	2.50	52.88	53.44	28	24	2.87	3.16
HHD	43.60	44.30	30	35	2.32	2.45	39.03	38.73	28	25	2.65	2.12
HMLD	19.70	20.93	30	32	1.63	1.61	19.24	19.62	26	25	1.48	1.72
HAPD	18.32	19.62	30	32	1.35	1.52	17.78	17.79	26	25	1.56	1.41
HAB	41.80	41.97	28	33	2.11	2.08	38.23	38.10	28	24	1.86	1.37
RML	246.39	247.32	28	33	11.12	12.00	223.61	225.96	22	22	9.81	9.20
RMLD	13.12	13.55	28	33	1.38	1.20	12.52	12.77	23	21	0.97	1.10
RAPD	10.76	11.42	28	33	0.75	0.61	10.36	10.34	23	21	0.62	0.63
RMLH	20.83	21.39	28	33	1.25	1.20	18.88	19.13	20	22	1.11	1.11
RAPH	21.34	21.79	28	32	1.30	1.34	19.35	19.68	20	22	1.16	1.13
RAB	24.50	24.66	28	33	1.36	1.64	22.45	22.92	22	21	1.17	1.50
UML	264.94	266.37	27	30	12.92	12.59	242.94	242.96	24	24	10.82	9.38
UMLD	11.67	12.45	27	30	0.98	0.85	11.17	11.15	24	24	0.78	0.92
UAPD	13.86	14.34	27	30	1.03	1.34	12.88	13.19	24	24	1.17	0.93
FML	436.96	433.63	34	31	17.70	15.17	405.74	406.57	27	21	12.41	12.52
FBL	435.30	430.34	32	31	17.60	15.16	402.64	403.28	26	20	12.45	12.80
FEB	80.19	79.59	31	33	3.89	4.24	71.43	71.04	27	24	3.10	2.72
FAB	69.60	69.24	31	33	3.27	3.86	61.87	61.64	27	24	3.17	2.85
FHD	43.98	43.53	33	36	2.14	2.29	38.76	39.19	29	23	1.23	1.43
FMLD	24.69	24.88	34	32	1.92	1.78	23.28	23.48	27	22	1.55	1.48
FAPD	28.96	29.17	34	32	2.12	2.34	26.10	26.12	27	22	2.37	2.46
TML	374.07	373.97	30	30	17.15	15.71	342.54	342.77	24	26	13.75	14.46
TFL	370.26	370.61	30	30	16.84	15.41	339.00	338.61	24	26	13.70	14.13
TPB	75.11	74.90	29	30	3.92	3.73	67.15	67.50	24	23	2.89	3.44
TPAB	71.27	72.90	29	30	10.11	3.52	65.04	65.78	24	23	2.33	3.04
TMLD	21.98	22.28	30	30	1.90	1.68	19.76	20.66	24	27	1.52	1.94
TAPD	28.01	28.08	30	30	2.49	2.15	24.62	24.73	24	27	2.22	1.88
FIML	362.84	361.38	28	28	16.31	18.42	331.69	330.93	21	20	11.90	13.97
BIB	267.57		30		12.29		260.37		26		12.59	
IBL	149.35	150.96	23	27	6.64	6.55	141.14	143.12	21	25	5.39	5.57
ACH	48.68	48.13	31	31	1.84	2.18	44.37	44.26	27	29	1.87	1.86
TCH	64.68	64.22	19	18	3.77	3.10	58.71	58.83	17	15	3.25	3.56
TTB	29.27	29.01	20	20	1.58	1.48	26.21	26.81	18	17	1.23	1.37

POLLEY-SECRET

Dimension	MALES						FEMALES					
	Mean		n	Std. Dev.		Mean		n	Std. Dev.			
	left	right		left	right	left	right		left	right		
BBH	136.00		5	3.54		131.00		2	9.90			
GBL	171.00		5	7.25		172.50		2	19.09			
EUB	142.80		5	9.28		139.50		2	2.12			
UFH	79.93		4	1.06		77.19		2	1.36			
NAH	27.88		4	0.69		25.61		2	.23			
NAW	26.23		5	1.87		26.63		2	2.16			
ZYG	138.00		4	3.74		133.00		2	7.07			
JNB	32.95		3	1.34								
CML	152.67	150.25	3	4	8.08	5.44						
CAPD	10.17	10.53	3	4	0.76	1.06						
CSID	8.52	8.74	3	4	0.24	1.28						
C1	10.07		5	1.18		9.60		1				
XC2	34.28		6	1.74		33.82		1				
XC3	12.48		6	0.52		12.83		1				
XC4	12.30		5	0.33		12.23		1				
XC5	11.61		6	0.65		12.60		1				
XC6	12.07		6	0.63		13.07		1				
XC7	13.84		6	0.83		13.77		1				
XT1	16.39		6	0.66		15.16		1				
XT2	18.42		6	0.49		17.54		1				
XT3	17.49		6	0.65		17.59		1				
XT4	18.10		6	0.94		18.47		1				
XT5	18.95		6	0.58		19.26		1				
XT6	20.23		6	0.71		19.78		1				
XT7	20.71		6	1.01		19.93		1				
XT8	20.72		6	1.26		20.58		1				
XT9	21.93		6	1.14		20.78		1				
XT10	22.79		6	1.64		21.74		1				
XT11	22.90		6	1.14		20.69		1				
XT12	24.06		6	1.10		23.55		1				
XL1	25.75		6	1.36		24.52		1				
XL2	26.42		6	0.80		24.96		1				
XL3	27.50		6	1.10		25.30		1				
XL4	28.59		6	1.29		26.35		1				

POLLEY-SECRET, CONTINUED

Dimension	MALES						FEMALES					
	Mean		<i>n</i>		Std. Dev.		Mean		<i>n</i>		Std. Dev.	
	left	right			left	right	left	right			left	right
XL5	29.14		6		0.91		26.76		1			
S1	30.19		6		1.31							
SML	107.14		6		4.11							
HML	301.25	302.58	6	6	8.73	10.88		296.50		1		
HEB	57.67	58.08	6	6	2.82	2.20		55.50		1		
HHD	43.14	44.16	5	6	1.36	0.31		40.44		1		
HMLD	18.29	20.48	6	6	1.17	2.02		18.73		1		
HAPD	16.79	18.03	6	6	1.25	1.98		17.54		1		
HAB	40.53	40.58	6	6	1.90	1.49		36.47		1		
RML	240.20	237.70	5	5	7.08	9.91		241.50		1		
RMLD	11.67	12.18	5	6	0.93	0.64	11.36	11.38	1	1		
RAPD	10.15	10.67	5	6	0.80	0.84	10.28	10.19	1	1		
RMLH	20.37	20.37	5	5	0.39	0.71		19.36		1		
RAPH	21.21	21.05	5	4	0.50	0.22		19.24		1		
RAB	24.71	25.07	5	4	0.99	1.26	22.39	22.97	1	1		
UML	261.88	254.88	4	4	3.73	8.93		260.00		1		
UMLD	10.81	11.05	4	5	0.42	0.68		10.52		1		
UAPD	11.98	12.00	4	5	1.05	1.84		12.57		1		
FML	420.00	417.75	6	6	12.73	13.31		406.00		1		
FBL	416.17	412.92	6	6	12.62	12.67		404.00		1		
FEB	77.50	78.75	5	4	2.18	2.10	71.50	71.00	1	1		
FAB	68.53	68.52	5	6	3.40	2.58	60.75	60.92	1	1		
FHD	43.58	43.42	6	6	1.35	1.50	40.27	40.30	1	1		
FMLD	23.32	22.91	6	6	2.33	2.15		24.74		1		
FAPD	27.51	27.06	6	6	2.55	2.11		23.60		1		
TML	358.75	362.30	6	5	11.05	7.51	346.00	344.00	1	1		
TFL	355.92	359.76	6	5	11.44	7.71	344.00	343.00	1	1		
TPB	73.83	73.50	6	5	1.29	1.22	68.00	69.00	1	1		
TPAB	71.90	72.40	6	5	1.56	1.45	68.93	66.85	1	1		
TMLD	19.10	22.03	6	5	1.20	1.91	19.42	24.44	1	1		
TAPD	27.03	27.06	6	5	1.58	.75	27.20	25.32	1	1		
FIML	345.63	350.75	4	4	11.24	8.01	335.00	337.00	1	1		
BIB	263.17		6		12.29							
IBL	147.75	149.33	4	6	5.12	4.13		149.00				
ACH	48.76	48.88	5	6	1.59	1.87	44.15	45.16	1	1		
TCH	59.25	63.00	4	3	3.88	4.58	60.00	60.50	1	1		
TTB	27.67	29.93	4	3	2.51	1.15	28.30	28.77	1	1		

PRINCE RUPERT HARBOUR

Dimension	MALES						FEMALES					
	Mean		n	Std. Dev.		Mean		n	Std. Dev.			
	left	right		left	right	left	right		left	right		
BBH	137.71		38	4.83		128.33		15	6.52			
GBL	188.97		39	6.90		177.47		15	4.69			
EUB	142.82		38	5.55		140.07		15	4.65			
UFH	83.50		31	4.99		78.86		12	4.93			
NAH	29.57		15	2.28		26.16		6	1.44			
NAW	24.86		37	1.66		23.77		15	1.72			
ZYG	144.51		35	6.07		137.57		14	6.00			
JNB	29.88		23	3.18		25.91		12	2.39			
CML	153.64	149.75	28	28	8.32	7.13	137.18	134.23	17	15	9.04	8.34
CAPD	12.33	12.40	31	28	1.36	1.25	10.35	10.57	17	15	1.18	1.18
CSID	11.02	10.73	31	28	1.42	1.23	9.00	9.19	17	15	1.09	1.44
C1	11.66		29	1.21		10.31		14	1.54			
XC2	38.25		35	2.58		34.92		16	2.61			
XC3	13.15		35	1.21		11.32		16	1.07			
XC4	13.10		35	1.18		11.20		16	1.05			
XC5	12.43		36	1.12		11.15		16	1.14			
XC6	12.52		36	1.02		11.80		16	1.04			
XC7	14.09		36	1.01		13.15		16	1.22			
XT1	16.27		36	0.87		15.32		18	1.25			
XT2	18.17		35	1.10		17.20		18	1.21			
XT3	18.31		35	1.14		17.20		18	1.27			
XT4	19.24		35	0.86		17.57		18	1.20			
XT5	19.80		34	0.90		18.26		18	1.29			
XT6	20.34		35	0.92		19.05		18	1.28			
XT7	20.86		35	1.02		19.46		18	1.48			
XT8	21.44		35	1.14		19.62		18	1.39			
XT9	21.79		35	1.11		20.32		18	1.45			
XT10	22.22		35	1.26		20.58		18	1.31			
XT11	22.69		36	1.51		21.26		18	1.16			
XT12	24.06		36	1.24		23.29		18	1.35			
XL1	25.64		37	1.51		25.10		18	1.74			
XL2	25.79		37	1.40		25.38		17	1.47			
XL3	26.71		36	1.69		25.81		16	1.48			
XL4	27.44		36	1.79		26.00		15	1.23			

PRINCE RUPERT HARBOUR, CONTINUED

Dimension	MALES						FEMALES					
	Mean		n		Std. Dev.		Mean		n		Std. Dev.	
	left	right			left	right	left	right			left	right
XL5	27.74		38		1.73		26.53		18		1.68	
S1	31.22		35		2.23		28.04		17		1.91	
SML	109.34		14		6.82		110.37		7		9.88	
HML	308.77	311.54	35	36	10.83	11.85	283.97	287.64	17	14	15.72	17.74
HEB	62.46	63.17	35	36	3.14	3.36	55.06	55.72	17	16	2.49	3.25
HHD	47.10	47.57	36	36	2.16	2.41	41.09	41.15	18	15	2.49	1.85
HMLD	24.00	24.98	36	36	1.67	1.86	20.10	20.61	18	15	1.92	2.23
HAPD	22.62	23.38	36	37	1.86	1.69	19.98	20.27	18	15	1.86	2.37
HAB	46.67	46.95	37	37	2.33	2.30	40.71	40.56	17	16	1.82	2.48
RML	240.72	242.12	32	37	8.28	7.52	213.84	214.42	16	13	12.60	17.18
RMLD	16.05	16.59	32	38	1.32	1.63	14.02	14.46	17	14	0.94	0.90
RAPD	12.52	12.77	32	38	0.89	0.94	10.62	10.75	17	14	0.66	0.80
RMLH	23.03	23.43	35	37	1.47	1.41	19.62	19.71	17	13	1.01	1.11
RAPH	24.00	24.28	35	37	1.75	1.61	20.36	20.29	17	13	1.24	1.22
RAB	27.67	27.85	31	35	1.56	1.43	24.26	24.75	14	13	0.85	1.44
UML	261.55	261.90	33	35	8.08	8.26	233.64	234.56	14	16	15.15	15.76
UMLD	13.66	14.16	33	35	1.00	1.01	11.98	11.91	14	16	0.59	0.60
UAPD	16.93	18.06	33	35	1.21	1.48	13.99	14.96	14	16	1.45	1.75
FML	421.28	417.63	36	34	14.85	14.90	387.28	393.08	16	13	21.01	19.37
FBL	418.97	415.10	33	34	14.41	14.63	386.23	392.67	15	12	21.10	19.17
FEB	82.28	82.47	30	33	3.36	3.27	73.25	73.04	14	12	3.10	3.22
FAB	73.16	73.51	35	34	3.31	2.71	63.64	62.30	15	16	3.19	3.73
FHD	46.45	46.86	37	36	2.31	2.03	41.30	41.59	18	15	2.38	2.62
FMLD	27.59	27.00	36	36	1.55	1.59	25.47	25.09	16	14	2.23	1.96
FAPD	28.43	28.20	36	36	1.55	1.53	24.63	24.40	16	14	2.09	2.14
TML	345.68	346.19	31	32	14.18	14.09	316.29	313.32	12	11	18.77	18.44
TFL	341.52	341.89	32	32	13.45	13.87	321.33	310.04	12	11	26.33	18.38
TPB	77.52	77.29	32	31	3.40	3.31	69.55	68.00	11	11	3.24	2.41
TPAB	75.67	75.25	32	31	3.44	3.04	67.95	66.49	11	11	3.21	2.40
TMLD	21.53	23.31	32	34	1.72	1.72	18.88	20.57	13	10	1.40	1.80
TAPD	27.44	27.10	31	34	1.86	1.65	23.34	23.27	14	10	1.70	1.37
FIML	334.06	330.55	18	11	11.36	15.26	316.33	299.67	3	3	10.26	3.51
BIB	276.74		21		9.82		264.94		9		17.30	
IBL	155.50	155.69	14	13	6.79	7.24	151.75	147.13	8	8	8.55	6.60
ACH	51.77	51.81	31	36	2.41	2.49	46.00	46.03	16	13	2.25	3.34
TCH	65.45	67.27	32	31	2.64	2.42	58.97	59.85	16	13	3.18	2.91
TTB	31.06	31.33	36	34	1.47	1.44	27.99	28.14	17	15	1.71	1.34

COAST SALISH

Dimension	MALES						FEMALES					
	Mean		n	Std. Dev.		Mean		n	Std. Dev.			
	left	right		left	right	left	right		left	right		
BBH	128.56		9	8.60		128.00		9	7.50			
GBL	167.11		9	8.25		169.88		8	6.03			
EUB	146.11		9	8.21		139.78		9	7.68			
UFH	80.71		10	5.08		79.10		9	5.29			
NAH	27.80		10	2.06		29.45		7	2.07			
NAW	25.11		10	1.71		24.46		7	2.08			
ZYG	140.90		10	6.30		132.67		9	7.57			
JNB	26.07		14	4.08		24.51		8	3.46			
CML	145.65	145.00	17	17	8.37	9.39	139.31	138.19	8	8	10.98	7.83
CAPD	11.13	11.42	17	17	0.69	0.78	9.64	9.80	8	8	0.62	0.94
CSID	9.76	10.00	17	17	0.96	1.27	8.56	8.62	8	8	0.84	0.98
C1	10.23		18	1.24		10.13		9	1.77			
XC2	36.83		18	2.17		34.21		9	2.27			
XC3	12.87		18	0.96		11.76		9	1.41			
XC4	12.48		18	0.84		11.33		9	0.92			
XC5	12.00		18	1.02		10.77		9	0.47			
XC6	11.94		17	0.81		11.63		10	0.74			
XC7	13.78		17	0.82		12.85		8	0.97			
XT1	15.88		18	0.91		14.67		8	0.78			
XT2	17.31		17	1.14		15.88		9	0.87			
XT3	17.86		17	0.91		16.49		9	0.65			
XT4	18.79		18	1.06		17.50		9	1.08			
XT5	19.26		18	1.00		18.04		9	1.01			
XT6	19.84		18	1.20		18.49		7	0.84			
XT7	20.18		18	1.04		19.34		7	1.10			
XT8	20.80		18	1.06		19.43		8	2.04			
XT9	21.40		17	0.99		20.36		10	1.59			
XT10	21.75		19	1.05		20.42		9	2.04			
XT11	21.95		19	1.06		21.37		9	2.19			
XT12	23.49		17	0.87		22.98		9	2.25			
XL1	25.02		17	1.35		24.46		9	2.56			
XL2	25.44		18	1.31		25.27		9	1.47			
XL3	25.84		18	1.74		25.72		9	2.13			
XL4	26.42		17	1.40		25.38		9	1.37			

COAST SALISH, CONTINUED

Dimension	MALES						FEMALES					
	Mean		<i>n</i>		Std. Dev.		Mean		<i>n</i>		Std. Dev.	
	left	right			left	right	left	right			left	right
XL5	26.78		17		1.71		25.87		9		1.74	
S1	30.14		16		1.07		27.64		9		2.49	
SML	110.08		13		9.51		106.11		6		14.99	
HML	303.94	303.89	18	13	10.41	10.76	288.85	289.89	10	9	14.53	9.43
HEB	58.68	58.94	17	16	3.96	3.68	53.45	55.22	10	9	3.42	2.48
HHD	43.26	43.53	18	13	2.26	2.35	39.04	39.34	10	9	1.98	2.02
HMLD	20.91	21.25	18	13	1.94	1.84	19.00	19.23	10	9	1.53	1.80
HAPD	20.02	20.62	18	13	1.59	1.70	18.50	18.91	10	9	1.78	1.54
HAB	42.01	42.42	19	16	3.39	2.72	38.31	39.33	9	10	2.05	1.91
RML	237.00	239.73	17	15	9.54	10.89	225.67	225.39	9	9	12.01	13.41
RMLD	14.89	14.83	17	15	1.18	1.04	13.42	13.79	9	9	1.01	1.30
RAPD	11.54	11.44	17	14	0.76	0.82	10.29	10.38	9	9	0.83	0.65
RMLH	21.05	20.93	16	16	1.70	1.43	18.79	19.54	8	8	1.22	1.17
RAPH	21.81	21.52	16	15	1.89	1.78	19.33	20.03	9	8	1.25	1.05
RAB	25.11	25.35	18	16	2.06	1.61	23.54	23.43	10	10	1.19	1.41
UML	255.53	258.10	17	15	9.86	9.70	244.75	246.00	8	9	11.21	12.98
UMLD	12.76	13.14	17	15	1.29	0.97	11.00	11.54	8	9	0.91	1.19
UAPD	14.47	15.06	17	15	1.18	1.29	12.67	13.28	8	9	0.79	0.75
FML	419.50	417.69	19	18	14.14	13.63	403.06	402.25	8	10	15.15	17.64
FBL	416.11	414.61	19	18	13.94	14.06	399.50	398.50	8	10	15.82	16.65
FEB	76.62	77.57	17	15	4.60	4.78	74.07	72.11	7	9	4.01	4.45
FAB	66.41	67.50	17	15	4.88	4.50	63.40	62.48	7	9	4.07	3.36
FHD	43.75	43.91	19	19	2.32	2.52	41.04	40.67	8	10	1.62	1.88
FMLD	25.44	25.20	19	18	1.39	1.41	23.93	23.45	8	10	1.18	1.47
FAPD	27.67	27.20	19	18	1.54	1.76	25.72	26.06	8	10	1.03	1.50
TML	345.33	348.79	18	14	12.04	9.35	331.50	333.17	8	9	15.46	16.76
TFL	343.42	345.04	18	14	11.13	9.55	327.69	328.72	8	9	15.67	15.85
TPB	71.71	71.79	17	14	3.77	4.15	68.17	68.13	6	8	3.64	3.68
TPAB	69.78	69.94	17	14	4.37	4.30	66.36	65.57	6	8	3.64	3.80
TMLD	20.58	22.83	18	14	1.38	2.21	19.48	20.41	8	9	1.85	.98
TAPD	25.58	26.39	18	14	1.65	2.57	24.13	24.13	8	9	1.71	1.97
FIML	333.79	340.94	14	9	11.27	10.46	317.81	323.00	8	5	16.28	21.92
BIB	263.10		15		11.37		255.88		8		14.50	
IBL	150.79	150.00	14	12	6.34	6.74	146.86	145.83	7	6	7.36	6.62
ACH	48.75	48.57	17	17	2.30	2.47	46.38	45.29	8	9	2.17	2.38
TCH	63.37	63.50	15	16	3.15	3.41	58.88	60.15	8	10	2.43	1.90
TTB	28.37	28.70	16	16	2.10	2.11	27.30	27.33	8	10	1.61	1.43

KWAKIUTL

Dimension	MALES						FEMALES					
	Mean		n	Std. Dev.		Mean		n	Std. Dev.			
	left	right		left	right	left	right		left	right		
BBH	130.53		15	4.82		127.11		9	4.17			
GBL	179.27		15	10.10		173.11		9	7.64			
EUB	136.60		15	5.65		136.56		9	6.21			
UFH	87.03		15	5.00		84.07		8	4.59			
NAH	27.21		14	1.72		26.74		8	1.50			
NAW	23.50		15	1.49		23.66		8	1.86			
ZYG	136.60		15	4.37		131.50		8	5.18			
JNB	25.05		9	1.96		21.32		6	1.92			
CML	149.50	146.44	13	16	8.56	11.65	141.05	137.54	10	11	10.44	9.54
CAPD	11.36	11.78	13	16	1.26	1.31	9.60	9.66	10	11	0.93	0.96
CSID	9.98	9.87	13	16	1.41	1.19	7.52	8.20	10	11	0.81	1.01
C1	10.94		15	1.43		9.63		11	1.15			
XC2	36.49		12	2.97		33.70		10	1.86			
XC3	12.80		12	1.24		11.24		10	1.02			
XC4	12.28		8	1.61		11.66		9	0.76			
XC5	11.99		9	1.09		11.68		9	0.85			
XC6	12.29		12	0.92		11.78		10	0.96			
XC7	13.86		12	1.13		13.27		10	0.89			
XT1	16.53		13	0.86		15.43		11	0.84			
XT2	17.80		11	1.02		17.41		10	0.92			
XT3	17.60		11	1.32		17.55		10	0.94			
XT4	18.79		12	1.19		17.98		11	0.99			
XT5	19.22		14	1.33		18.45		11	1.16			
XT6	19.62		14	0.88		19.23		10	0.80			
XT7	19.92		13	1.03		19.65		10	0.87			
XT8	20.28		13	1.28		20.12		10	1.03			
XT9	21.03		14	1.51		20.69		11	1.19			
XT10	21.00		14	1.41		20.48		9	1.22			
XT11	21.91		15	1.25		21.08		11	1.53			
XT12	23.47		15	1.45		22.35		9	1.85			
XL1	25.21		15	1.17		24.49		9	1.40			
XL2	25.75		15	1.38		25.63		9	0.92			
XL3	27.11		15	1.30		26.54		10	1.49			
XL4	27.53		15	1.61		27.15		10	1.38			

KWAKIUTL, CONTINUED

Dimension	MALES						FEMALES					
	Mean		<i>n</i>		Std. Dev.		Mean		<i>n</i>		Std. Dev.	
	left	right			left	right	left	right			left	right
XL5	28.05		15		2.36		27.01		10		2.19	
S1	30.52		9		2.13		27.49		10		2.48	
SML	108.04		7		16.05		98.99		5		10.26	
HML	308.54	314.13	14	16	14.24	13.22	286.25	292.94	10	8	17.16	18.43
HEB	58.92	58.27	12	15	4.77	4.71	52.35	53.00	10	9	2.94	3.91
HHD	44.08	45.56	14	16	2.71	3.38	40.37	40.82	11	10	2.61	2.32
HMLD	20.63	21.74	14	16	1.56	2.00	17.47	17.84	10	8	1.50	1.95
HAPD	19.95	21.31	14	16	1.79	1.45	17.60	17.99	10	8	1.91	2.48
HAB	43.50	43.95	12	15	3.73	3.88	38.15	39.62	10	9	2.81	2.88
RML	235.50	235.05	11	11	12.46	15.04	221.13	220.57	8	7	12.27	12.85
RMLD	14.65	15.54	11	11	1.08	1.44	12.57	13.13	8	7	1.49	1.59
RAPD	11.71	11.99	11	11	0.89	1.16	9.95	10.01	8	7	0.82	0.97
RMLH	21.66	21.91	10	11	1.18	1.88	19.53	19.50	8	7	1.58	1.62
RAPH	23.09	22.57	9	11	1.03	1.62	20.24	20.19	8	7	1.66	1.83
RAB	25.14	26.05	11	13	1.58	2.18	24.66	24.61	9	8	0.99	1.41
UML	257.27	255.28	11	9	12.57	13.91	237.50	235.63	8	8	11.75	14.86
UMLD	12.51	13.05	11	9	1.02	1.23	11.13	11.17	8	8	1.00	1.31
UAPD	15.44	16.31	10	9	1.52	2.29	13.49	13.83	8	8	1.83	1.47
FML	420.73	409.71	15	12	20.55	24.76	391.72	383.15	9	10	28.39	26.85
FBL	417.73	406.75	15	12	20.45	24.77	388.67	380.20	9	10	27.57	25.81
FEB	78.27	77.46	15	13	4.02	3.88	70.90	70.00	10	10	4.40	5.18
FAB	69.21	68.41	15	13	3.52	2.60	61.07	61.60	10	10	3.68	4.07
FHD	43.98	43.08	15	13	2.50	3.08	39.76	39.80	10	10	2.62	2.29
FMLD	25.23	24.34	15	12	1.58	0.91	22.01	21.74	9	10	3.47	2.68
FAPD	27.02	25.89	15	12	1.62	1.89	23.38	23.14	9	10	2.89	2.78
TML	343.78	340.25	9	10	18.88	15.97	319.14	318.82	11	11	21.41	20.89
TFL	340.00	336.70	9	10	19.43	16.11	315.00	314.86	11	11	21.17	20.64
TPB	73.79	73.40	12	10	3.98	3.66	66.85	67.36	10	11	4.46	4.50
TPAB	71.81	71.98	12	10	3.79	3.92	65.17	65.43	10	11	4.61	5.20
TMLD	20.95	21.03	9	10	1.75	1.41	18.16	18.74	11	11	1.52	2.24
TAPD	25.10	25.19	9	10	2.02	2.43	21.48	21.84	11	11	3.11	3.24
FIML	328.33	330.11	9	9	18.10	17.88	311.39	311.72	9	9	21.68	20.62
BIB	261.94		8		11.37		252.17		9		16.08	
IBL	145.80	151.00	5	4	6.34	3.92	146.00	144.50	6	6	2.00	7.29
ACH	48.50	47.84	8	7	1.89	2.79	44.72	44.54	8	8	2.88	3.13
TCH	63.40	65.19	5	8	3.58	4.42	59.11	60.67	9	6	2.52	3.97
TTB	29.43	29.38	7	8	1.56	1.16	26.94	27.36	10	10	1.79	1.31

NOOTKA

Dimension	MALES						FEMALES					
	Mean		<i>n</i>	Std. Dev.		Mean		<i>n</i>	Std. Dev.			
	left	right		left	right	left	right		left	right		
BBH	129.86		7	6.01		119.00		3	4.58			
GBL	165.29		7	6.24		162.00		3	13.89			
EUB	160.43		7	11.86		142.67		3	12.01			
UFH	79.69		7	5.47		82.29		2	3.56			
NAH	29.36		7	2.91		25.89		2	2.71			
NAW	25.00		7	1.43		24.21		2	1.42			
ZYG	146.57		7	9.02		129.33		3	3.51			
JNB	24.94		8	3.11		22.19		3	2.23			
CML	157.31	158.00	8	8	9.66	10.27	135.67	133.50	3	3	3.51	4.09
CAPD	11.18	11.38	8	8	0.82	0.85	9.29	10.12	3	3	0.28	0.21
CSID	9.20	9.13	8	8	0.85	0.67	7.82	8.07	3	3	0.82	0.62
C1	12.23		8	1.20		8.73		3	0.28			
XC2	37.75		8	2.46		33.22		3	0.28			
XC3	12.83		8	1.23		11.53		3	0.40			
XC4	12.37		7	0.96		11.11		3	0.43			
XC5	12.06		7	0.64		10.69		3	0.67			
XC6	12.43		8	0.97		11.09		3	0.54			
XC7	14.06		8	1.31		12.95		3	0.72			
XT1	15.88		8	0.94		15.04		3	0.97			
XT2	17.70		8	1.57		17.00		3	0.63			
XT3	17.47		8	0.92		17.11		3	0.56			
XT4	18.10		8	1.49		17.52		3	0.35			
XT5	19.02		8	1.39		17.94		3	0.83			
XT6	19.53		8	0.88		18.59		3	1.03			
XT7	19.56		8	1.21		18.84		3	1.10			
XT8	20.76		8	1.15		19.29		3	1.41			
XT9	21.35		8	1.11		19.80		3	1.79			
XT10	21.58		8	1.46		20.13		3	1.84			
XT11	21.32		8	1.53		20.73		3	2.01			
XT12	23.71		8	1.23		22.98		3	2.45			
XL1	25.55		8	0.84		25.10		3	1.72			
XL2	26.39		8	1.22		26.04		3	1.49			
XL3	27.63		8	1.46		26.93		3	1.54			
XL4	27.59		8	2.02		25.71		3	1.84			

NOOTKA, CONTINUED

Dimension	MALES						FEMALES					
	Mean		n	Std. Dev.		Mean		n	Std. Dev.			
	left	right		left	right	left	right		left	right		
XL5	27.96		8	1.57		26.61		3	1.59			
S1	29.61		8	1.64		28.95		3	1.89			
SML	103.31		8	9.68		103.16		3	5.04			
HML	299.67	302.56	6	8	19.28	21.44	273.83	279.50	3	3	6.79	9.66
HEB	60.83	61.56	6	8	6.08	6.13	50.67	49.83	3	3	0.58	3.55
HHD	43.39	44.08	6	8	3.45	3.86	37.14	37.83	3	3	1.64	2.10
HMLD	20.44	21.14	6	8	1.80	1.97	17.84	18.52	3	3	0.60	0.71
HAPD	19.89	20.46	6	8	2.03	1.81	16.93	17.64	3	3	1.75	2.09
HAB	43.98	44.17	6	8	4.57	3.74	37.49	36.70	3	3	1.25	1.24
RML	230.92	232.75	6	8	10.37	12.36	210.17	214.17	3	3	6.51	5.84
RMLD	14.97	15.79	6	8	1.26	1.79	12.89	13.38	3	3	0.41	0.87
RAPD	11.58	11.78	6	8	0.80	1.10	9.51	9.92	3	3	0.09	0.36
RMLH	21.64	22.22	6	8	2.52	2.44	18.40	18.62	3	3	0.84	0.54
RAPH	22.90	23.04	6	8	2.56	2.62	19.13	18.76	3	3	0.51	0.55
RAB	26.40	25.70	6	8	1.82	2.03	23.39	23.84	3	3	1.14	1.25
UML	250.00	250.88	7	8	11.55	11.36	229.50	232.83	3	3	4.44	5.80
UMLD	12.36	13.01	7	8	1.23	1.24	10.72	10.73	3	3	0.47	0.28
UAPD	14.64	15.10	7	8	1.62	1.94	11.86	12.74	3	3	1.36	1.07
FML	413.25	411.50	8	8	21.73	21.85	378.83	380.00	3	3	6.79	7.09
FBL	410.25	408.38	8	8	22.94	22.56	375.33	376.33	3	3	7.69	6.53
FEB	78.50	78.19	8	8	5.13	6.04	67.33	68.33	3	3	0.76	0.76
FAB	67.34	67.72	8	8	4.87	5.15	59.44	60.30	3	3	1.56	1.86
FHD	44.45	44.61	8	8	2.53	2.68	39.24	38.83	3	3	0.65	2.26
FMLD	26.01	25.36	8	8	1.74	1.20	22.24	21.88	3	3	0.34	0.82
FAPD	26.96	27.47	8	8	2.78	2.29	22.34	22.58	3	3	0.66	1.08
TML	338.38	338.13	8	8	19.23	20.26	308.83	308.17	3	3	8.22	7.94
TFL	335.75	335.00	8	8	17.90	18.61	338.17	338.33	3	3	50.10	49.51
TPB	73.94	73.44	8	8	4.94	5.30	63.00	63.00	3	3	1.00	1.73
TPAB	71.35	71.35	8	8	4.46	5.15	61.96	62.13	3	3	1.15	1.33
TMLD	19.99	22.14	8	8	1.61	2.07	18.18	18.66	3	3	0.78	0.57
TAPD	24.65	25.95	8	8	2.35	2.64	21.13	21.46	3	3	0.41	0.41
FIML	325.56	324.19	8	8	16.69	17.18	298.00	296.17	3	3	5.68	7.97
BIB	273.25		8		11.12		248.83		3		7.29	
IBL	153.88	153.75	8	8	6.88	7.01	141.00	139.67	3	3	5.57	6.51
ACH	49.50	48.96	8	8	2.89	2.41	43.66	43.14	3	3	1.43	2.30
TCH	67.21	67.38	7	8	3.13	4.74	56.67	55.67	3	3	4.04	3.06
TTB	28.97	29.08	8	8	1.22	1.03	26.50	25.89	3	3	0.64	0.62

SOURIS RIVER

Dimension	MALES					FEMALES				
	Mean		n	Std. Dev.		Mean		n	Std. Dev.	
	left	right		left	right	left	right		left	right
BBH	133.17		6		5.95		129.00	3		3.61
GBL	185.67		6		6.41		181.33	3		3.51
EUB	139.17		6		3.71		135.33	3		2.08
UFH	82.16		6		7.27		79.03	3		1.78
NAH	30.00		4		2.37		30.56	2		2.50
NAW	25.94		6		1.79		24.75	3		.95
ZYG	142.71		7		4.57		135.33	3		4.16
JNB	34.90		3		0.65		29.09	1		
CML	165.10	166.80	5	5	14.03	6.35	140.00	1		
CAPD	11.97	12.91	5	5	0.84	1.08	9.06	1		
CSID	9.97	10.50	5	5	0.49	1.23	8.81	1		
C1	10.06		5		0.79		9.70	1		
XC2	39.18		4		0.79		40.76	1		
XC3	13.29		5		0.45		14.28	1		
XC4	12.17		4		0.25					
XC5	12.22		3		0.63		11.86	1		
XC6	12.71		6		0.35		13.01	2		0.35
XC7	14.39		4		0.48		15.34	1		
XT1	16.72		4		0.51		15.31	2		0.89
XT2	17.97		4		0.92		16.79	3		1.08
XT3	17.53		5		1.52		16.98	3		0.89
XT4	18.22		5		0.97		17.01	3		0.95
XT5	19.27		4		0.53		17.89	3		0.55
XT6	19.71		5		1.62		18.14	3		1.16
XT7	20.18		5		1.25		17.96	3		0.42
XT8	21.04		6		1.28		18.84	3		0.95
XT9	21.66		6		1.38		20.06	4		0.87
XT10	22.84		7		1.09		21.16	4		1.92
XT11	23.36		7		0.87		21.47	4		1.78
XT12	25.59		7		1.27		23.58	4		1.91
XL1	26.13		8		1.63		25.15	4		1.69
XL2	26.58		8		2.12		25.77	4		1.78
XL3	27.20		8		2.19		27.30	4		1.92
XL4	28.10		8		2.43		27.92	4		2.05

SOURIS RIVER, CONTINUED

Dimension	MALES						FEMALES					
	Mean		<i>n</i>		Std. Dev.		Mean		<i>n</i>		Std. Dev.	
	left	right			left	right	left	right			left	right
XL5	28.45		8		2.41		27.78		4		1.62	
S1	32.05		9		2.43		30.43		4		1.21	
SML	123.00		8		14.35		106.47		3		5.87	
HML	332.50	340.43	4	7	10.75	21.84	301.00	298.33	3	3	10.15	10.54
HEB	61.00	62.86	5	7	3.57	2.25	58.00	57.25	2	2	0.00	1.06
HHD	49.10	49.62	4	5	1.06	2.44	43.67	42.98	3	3	1.08	1.15
HMLD	22.99	22.81	4	7	1.94	.95	18.72	19.77	3	3	1.49	1.67
HAPD	20.74	22.12	4	7	1.20	1.27	19.90	20.83	3	3	1.79	1.50
HAB	44.00	44.34	5	6	2.36	1.70	41.65	39.88	2	2	0.90	1.16
RML	266.29	265.86	7	7	12.84	12.04	238.75	226.33	2	3	0.35	12.86
RMLD	14.52	14.78	7	7	1.31	1.33	14.59	14.04	2	3	1.09	1.21
RAPD	12.11	12.45	7	7	0.54	0.64	11.29	11.42	2	3	1.00	0.87
RMLH	22.28	22.47	7	7	1.06	1.16	21.73	19.75	2	3	0.76	1.15
RAPH	23.44	23.82	7	7	1.17	1.12	21.96	20.61	2	3	0.45	1.57
RAB	27.01	27.36	6	7	0.79	0.68	25.58	25.12	2	2	0.25	0.17
UML	280.38	284.94	4	8	16.72	11.98	241.00	252.50	1	3		9.84
UMLD	12.35	13.24	5	8	0.49	0.87	14.25	12.22	2	3	1.07	1.26
UAPD	14.75	15.27	5	8	1.20	0.93	15.52	13.28	2	3	2.84	1.40
FML	466.27	459.72	11	9	19.66	16.52	418.38	417.63	4	4	11.71	12.97
FBL	460.44	455.07	9	7	21.44	19.69	413.38	414.50	4	4	12.40	12.90
FEB	84.38	84.29	8	7	3.95	2.78	75.50	76.00	3	2	1.50	1.41
FAB	74.36	74.88	8	7	4.16	3.45	69.75	68.14	3	3	1.97	2.28
FHD	47.73	47.89	10	9	1.67	1.54	44.35	43.59	3	4	2.00	2.04
FMLD	27.73	26.47	11	9	1.85	1.77	26.60	25.40	4	4	1.23	1.93
FAPD	29.97	29.42	11	9	1.84	1.85	26.43	26.12	4	4	0.99	1.37
TML	391.96	391.61	11	9	22.73	18.90	352.00	349.38	3	4	10.21	9.71
TFL	386.59	386.97	10	9	23.32	18.77	347.57	344.88	3	4	11.51	9.51
TPB	78.75	79.33	8	6	4.27	2.48	71.83	72.17	3	3	2.93	1.61
TPAB	77.23	78.21	8	6	4.00	2.66	70.58	70.47	3	3	2.22	2.09
TMLD	22.89	25.80	11	9	1.90	1.86	19.55	22.30	3	4	1.86	1.34
TAPD	28.46	28.55	11	9	2.01	1.71	23.06	24.15	3	4	1.88	1.08
FIML	376.94	384.50	8	6	19.61	13.54	344.50	340.00	2	3	2.12	5.07
BIB	282.89		9		16.67		277.50		3		9.73	
IBL	167.30	168.67	10	9	6.99	8.70	156.50	159.33	2	3	10.61	6.51
ACH	54.00	54.09	10	10	1.93	2.07	51.54	50.05	2	4	4.63	2.54
TCH	65.86	65.43	7	7	3.68	3.82	61.13	63.25	4	2	1.55	0.35
TTB	31.09	30.50	7	7	1.87	1.61	29.23	30.04	4	2	0.79	0.11

SNOWFLAKE

Dimension	MALES						FEMALES					
	Mean		n	Std. Dev.		Mean		n	Std. Dev.			
	left	right		left	right	left	right		left	right		
BBH	129.67		3	3.79								
GBL	189.67		3	6.03								
EUB	139.67		3	5.51								
UFH	81.67		4	6.79								
NAH	29.30		4	4.43								
NAW	25.54		4	1.70		22.56		1				
ZYG	137.50		4	5.51								
JNB	33.04		3	3.45		26.26		2	3.20			
CML	157.00	158.83	3	3	7.57	8.40	133.25	128.00	2	1	1.06	
CAPD	10.99	11.97	3	3	1.41	0.90	10.42	9.70	2	1	0.17	
CSID	10.47	11.30	3	3	1.45	1.69	8.46	9.26	2	1	0.30	
C1	9.91		1			10.61		2	0.14			
XC2	38.48		2	0.94		35.05		2	3.61			
XC3	13.48		2	0.33		12.22		2	2.34			
XC4						11.79		2	2.13			
XC5						10.68		2	1.93			
XC6	10.36		1			10.93		2	0.98			
XC7						13.43		2	1.82			
XT1	15.21		1			14.89		2	0.19			
XT2	16.80		1			16.17		2	0.86			
XT3	18.24		1			17.08		1				
XT4	18.66		1			17.91		1				
XT5	20.43		1			17.18		1				
XT6	19.97		1			18.51		1				
XT7	21.58		1			19.44		1				
XT8	22.06		1			20.58		1				
XT9	24.13		1			21.95		1				
XT10	24.41		1			21.47		1				
XT11	22.21		2	3.38		22.10		2	0.36			
XT12	26.87		1			21.61		1				
XL1	26.77		1			24.00		1				
XL2	27.14		1			26.54		2	2.89			
XL3	30.13		1			23.11		1				
XL4	29.44		1			25.18		1				

SNOWFLAKE, CONTINUED

Dimension	MALES						FEMALES					
	Mean		n	Std. Dev.		Mean		n	Std. Dev.			
	left	right		left	right	left	right		left	right		
XL5	28.80		1			27.79		1				
S1	31.96		1			29.92		1				
SML	122.53		1			111.96		1				
HML	320.40	321.00	5	4	21.92	22.26	303.75	293.00	2	1	22.27	
HEB	61.40	63.00	5	5	5.42	5.37	57.75	57.50	2	1	0.35	
HHD	46.62	46.89	4	3	3.92	4.79	42.28	42.45	2	1	1.69	
HMLD	22.59	24.11	5	4	2.10	1.38	18.95	18.15	2	1	1.87	
HAPD	20.93	22.94	5	4	1.62	2.36	20.56	19.51	2	1	2.21	
HAB	43.91	44.30	5	5	3.13	2.06	42.11	41.43	2	1	2.57	
RML	248.33	257.50	3	5	26.08	19.94	221.50	235.50	1	2	16.26	
RMLD	15.62	15.69	4	5	2.33	1.53	12.87	14.18	1	2	1.56	
RAPD	12.42	12.54	4	5	1.12	0.85	10.69	10.92	1	2	0.88	
RMLH	21.53	23.04	2	5	0.35	0.97	19.31	21.43	1	2	0.76	
RAPH	22.74	24.06	2	5	0.85	1.18	19.92	22.30	1	2	0.37	
RAB	26.43	27.98	3	5	1.81	2.27	23.34	26.16	1	2	2.76	
UML	269.20	279.00	5	4	21.06	12.05	260.75	242.00	2	1	27.93	
UMLD	12.48	13.07	5	4	1.54	1.23	11.23	10.98	2	1	0.49	
UAPD	15.61	16.07	5	4	1.39	0.94	14.40	13.05	2	1	2.16	
FML	448.50	457.50	2	4	0.71	17.31	434.00	413.50	2	1	24.75	
FBL	444.00	453.25	2	4	2.83	17.35	428.50	412.00	2	1	22.63	
FEB	84.75	84.33	2	3	0.35	5.69	70.50		1			
FAB	77.19	75.78	2	3	2.00	7.25	65.04		2		4.24	
FHD	46.99	46.56	2	3	0.43	1.93	42.70	41.09	2	1	1.80	
FMLD	27.69	28.02	2	4	0.59	1.52	25.18	23.30	2	1	0.89	
FAPD	30.44	30.86	2	4	0.81	2.48	27.17	24.83	2	1	1.05	
TML	385.88	376.80	4	5	18.11	22.37	341.00	365.50	1	2	30.41	
TFL	380.75	373.00	4	5	17.87	22.99	338.00	361.50	1	2	28.99	
TPB	78.90	79.38	5	4	4.45	3.59	66.00	70.25	1	2	6.01	
TPAB	77.19	77.62	5	4	4.66	4.12	64.93	66.98	1	2	6.01	
TMLD	23.15	25.35	5	5	1.30	2.25	19.49	22.13	1	2	1.77	
TAPD	30.62	28.70	5	5	3.04	2.98	23.78	25.05	1	2	2.39	
FIML	373.75	366.33	4	3	15.02	11.93		350.75		2	34.29	
BIB	310.00		1									
IBL		163.00		2		21.21	151.00		1			
ACH	52.63	49.64	1	2		4.45	43.00		1			
TCH		69.50		2		0.00	58.00		1			
TTB		32.30		2		0.08	28.23		1			

KIKLEWAIT (CHESTERFIELD INLET)

Dimension	MALES						FEMALES					
	Mean		n	Std. Dev.		Mean		n	Std. Dev.			
	left	right		left	right	left	right		left	right		
BBH	137.07		15	5.52		130.71		7	6.10			
GBL	186.33		15	6.58		176.14		7	8.03			
EUB	134.33		15	3.66		130.43		7	1.99			
UFH	83.00		15	5.42		77.67		7	5.70			
NAH	30.21		15	2.23		27.83		7	2.04			
NAW	22.28		15	1.18		21.63		7	1.27			
ZYG	140.21		14	3.26		130.29		7	5.22			
JNB	30.45		7	2.27		24.00		2	5.62			
CML	148.00	147.28	10	9	8.38	10.57	140.00	133.88	6	8	6.48	10.33
CAPD	10.93	11.17	10	9	0.76	1.07	9.57	10.12	6	8	0.66	0.77
CSID	10.07	10.69	10	9	1.62	1.72	8.82	9.17	6	8	0.77	0.93
C1	11.53		12	0.88		10.69		5	1.29			
XC2	35.66		13	4.40		31.12		6	2.13			
XC3	11.27		13	0.64		10.88		6	0.61			
XC4	11.52		11	0.60		10.97		5	0.66			
XC5	10.91		12	0.77		10.63		5	0.35			
XC6	11.13		11	0.64		11.04		5	0.42			
XC7	12.92		11	1.01		12.27		5	0.96			
XT1	15.01		11	1.07		14.03		7	0.98			
XT2	16.60		11	1.48		14.94		7	1.03			
XT3	17.22		10	1.45		15.25		7	0.95			
XT4	17.64		11	1.04		15.63		5	0.51			
XT5	18.39		12	1.01		16.51		5	0.55			
XT6	18.81		11	1.01		17.10		5	0.55			
XT7	19.78		9	1.11		17.57		5	0.43			
XT8	20.18		9	1.06		17.87		6	0.53			
XT9	20.34		10	1.16		18.57		4	0.47			
XT10	20.58		10	1.64		19.49		3	0.47			
XT11	20.81		11	1.83		19.83		7	0.78			
XT12	21.75		11	1.42		20.82		7	1.09			
XL1	23.36		12	2.20		21.35		8	1.11			
XL2	23.53		12	1.41		22.59		7	1.29			
XL3	24.35		13	1.73		22.89		8	1.23			
XL4	24.97		13	1.44		23.68		7	1.11			

KIKLEWAIT, CONTINUED

Dimension	MALES						FEMALES					
	Mean		<i>n</i>		Std. Dev.		Mean		<i>n</i>		Std. Dev.	
	left	right			left	right	left	right			left	right
XL5	25.06		13		1.77		23.51		8		1.34	
S1	28.96		12		2.14		25.65		7		1.29	
SML	103.08		11		7.88		100.62		5		5.08	
HML	305.00	308.42	14	13	9.64	11.59	281.08	285.13	6	8	12.24	9.94
HEB	58.58	60.15	13	13	5.05	4.01	53.64	54.57	7	7	3.35	3.19
HHD	46.02	46.22	12	13	3.59	3.17	40.61	40.99	6	8	3.17	1.47
HMLD	22.54	23.00	14	13	2.16	2.01	18.90	20.35	7	8	1.86	1.51
HAPD	22.39	23.59	14	13	1.52	1.83	21.54	21.75	7	8	1.24	1.53
HAB	44.18	44.99	13	13	3.45	3.26	40.03	40.66	7	7	2.60	2.43
RML	227.25	225.42	12	12	11.25	10.72	203.07	203.71	7	7	8.23	8.44
RMLD	16.14	15.85	12	12	1.65	1.79	14.44	14.65	7	8	1.00	1.32
RAPD	11.83	11.85	12	12	0.72	1.08	10.68	10.51	7	8	0.97	0.79
RMLH	22.15	22.43	11	10	1.87	2.03	19.45	19.00	6	7	1.20	1.61
RAPH	22.98	22.61	11	9	1.95	2.40	20.16	18.77	6	6	1.00	1.31
RAB	27.47	27.55	12	10	2.02	2.42	24.03	24.61	7	5	1.58	2.40
UML	246.13	243.96	12	12	9.21	10.58	221.92	222.67	6	6	8.82	7.87
UMLD	13.00	13.11	12	12	1.13	1.44	11.70	12.09	6	7	0.19	0.63
UAPD	15.01	15.38	12	12	1.07	1.78	14.40	13.61	6	7	1.05	1.27
FML	436.05	434.42	10	13	15.61	15.61	416.19	419.79	8	7	17.04	18.31
FBL	433.75	431.42	10	13	15.56	15.62	412.50	414.86	8	7	16.42	17.36
FEB	81.40	81.17	10	12	5.24	4.79	73.33	75.86	6	7	2.36	3.22
FAB	73.50	72.06	10	13	4.92	4.74	63.34	67.15	6	7	2.94	3.42
FHD	48.15	48.41	11	12	3.56	3.62	44.28	44.39	8	7	2.81	2.86
FMLD	28.83	28.11	10	13	1.90	1.69	26.01	25.47	8	7	1.71	1.77
FAPD	30.77	30.79	10	13	2.92	2.51	28.43	28.60	8	7	2.29	2.53
TML	354.50	353.62	11	13	10.15	10.14	333.19	334.75	8	8	8.80	7.43
TFL	349.81	348.50	11	13	10.10	9.35	329.13	330.50	8	8	9.33	7.93
TPB	77.29	76.65	7	10	4.56	4.23	69.70	69.80	5	5	3.49	1.89
TPAB	75.98	74.90	7	11	4.52	4.19	67.55	67.53	5	5	4.13	2.34
TMLD	21.72	23.33	10	13	1.46	1.35	20.71	21.89	8	8	1.51	1.75
TAPD	27.30	27.39	10	13	1.30	1.53	25.24	24.86	8	8	1.01	0.95
FIML	343.69	345.11	8	9	11.05	10.69	316.80	324.63	5	4	6.30	7.06
BIB	274.00		12		18.95		264.00		7		19.14	
IBL	157.40	159.42	10	12	7.99	9.49	153.50	149.75	2	4	3.54	4.19
ACH	54.66	53.73	13	14	3.73	4.02	49.39	49.88	6	8	2.34	1.91
TCH	66.33	68.00	9	9	4.92	3.32	61.40	61.58	5	6	2.61	2.69
TTB	31.99	32.36	9	9	1.93	2.39	28.12	27.65	5	7	1.16	1.06

SADLERMIUT

Dimension	MALES						FEMALES					
	Mean		n	Std. Dev.		Mean		n	Std. Dev.			
	left	right		left	right	left	right		left	right		
BBH	137.85		27	4.12		133.57		23	4.91			
GBL	186.78		27	4.81		179.65		23	4.90			
EUB	137.85		27	3.93		132.52		23	4.13			
UFH	84.69		27	4.82		78.43		22	4.90			
NAH	31.38		27	2.63		28.92		21	2.04			
NAW	22.01		27	1.71		21.94		22	1.73			
ZYG	142.52		27	4.97		133.54		22	3.25			
JNB	27.81		25	3.70		26.13		16	2.44			
CML	145.50	141.32	28	28	6.72	7.42	131.78	129.83	27	26	7.20	7.62
CAPD	11.32	11.99	29	28	1.02	1.20	9.40	9.68	27	26	1.07	1.23
CSID	9.72	10.19	29	28	1.03	1.21	8.61	8.64	27	26	1.01	1.02
C1	11.39		25	0.85		10.53		24	0.87			
XC2	35.77		29	2.17		34.73		21	1.69			
XC3	11.31		29	0.87		10.97		21	0.99			
XC4	11.12		29	0.90		10.58		19	0.74			
XC5	10.91		29	0.93		10.51		21	0.95			
XC6	10.95		29	0.77		10.97		23	0.79			
XC7	12.80		29	0.72		12.40		23	0.70			
XT1	15.32		29	0.95		14.78		23	0.82			
XT2	17.18		29	1.08		16.52		23	0.84			
XT3	17.42		29	1.26		16.86		23	0.71			
XT4	18.02		29	1.13		17.07		25	0.99			
XT5	18.60		29	1.30		17.32		25	1.02			
XT6	19.02		29	1.59		17.71		25	2.26			
XT7	19.85		29	1.36		19.08		24	1.36			
XT8	20.60		28	1.10		19.18		24	1.92			
XT9	21.46		28	1.35		20.10		24	1.63			
XT10	22.04		28	1.29		21.26		25	1.27			
XT11	22.43		29	1.25		21.30		25	1.11			
XT12	23.26		28	1.08		22.80		25	1.30			
XL1	23.71		28	1.47		23.99		25	1.21			
XL2	23.95		26	1.29		24.22		24	1.22			
XL3	24.43		27	1.54		24.35		24	1.86			
XL4	24.86		27	1.85		24.82		24	1.91			

SADLERMIUT, CONTINUED

Dimension	MALES						FEMALES					
	Mean		<i>n</i>		Std. Dev.		Mean		<i>n</i>		Std. Dev.	
	left	right			left	right	left	right			left	right
XL5	25.60		28		2.05		25.54		24		1.93	
S1	35.77		29		2.17		28.21		25		2.05	
SML	11.31		29		0.87		98.34		24		11.08	
HML	302.85	308.32	30	30	15.15	16.03	283.11	289.06	27	27	18.57	18.98
HEB	60.33	61.27	30	30	2.52	2.48	53.33	54.65	27	27	2.66	2.55
HHD	45.51	45.92	30	30	2.35	2.23	40.92	40.92	27	27	2.02	2.24
HMLD	22.04	23.07	29	30	2.14	2.41	18.72	20.22	27	27	1.39	1.40
HAPD	22.43	23.08	29	30	1.88	2.04	20.41	21.16	27	27	1.55	1.55
HAB	44.60	44.78	30	30	2.05	2.18	39.69	40.43	27	27	1.72	1.92
RML	219.63	222.21	30	14	9.08	9.35	201.69	203.02	27	25	14.30	14.41
RMLD	15.53	15.40	30	14	1.79	1.74	14.56	14.90	27	25	1.34	1.52
RAPD	11.46	11.44	30	14	0.98	0.95	9.88	10.35	27	25	0.80	0.97
RMLH	21.10	21.46	30	16	1.33	1.57	19.26	19.81	26	25	1.26	1.24
RAPH	22.25	22.17	30	15	1.81	1.60	19.78	20.11	26	25	1.15	1.32
RAB	26.30	27.06	29	29	1.42	1.55	24.19	24.82	27	25	1.56	1.36
UML	239.31	240.90	29	29	10.54	10.07	221.98	223.40	25	25	14.84	13.86
UMLD	12.61	13.33	29	29	1.32	1.19	10.97	11.58	25	25	0.96	0.96
UAPD	15.24	15.92	29	29	1.37	1.74	13.14	14.38	25	25	1.34	1.71
FML	438.14	441.71	26	26	21.68	22.23	407.04	407.65	24	26	25.58	23.81
FBL	433.62	436.60	26	26	21.86	22.36	402.40	403.62	24	26	24.25	23.96
FEB	82.91	83.86	27	25	3.29	3.64	75.66	75.98	22	24	3.19	3.39
FAB	73.85	74.44	27	26	3.20	3.51	65.65	65.99	24	26	3.40	3.34
FHD	48.19	48.36	27	27	2.23	2.33	43.55	43.75	25	26	1.94	1.89
FMLD	28.35	28.22	26	26	1.96	1.89	25.68	25.94	24	26	1.42	1.58
FAPD	30.40	30.55	26	26	2.24	2.32	27.32	27.42	24	26	1.83	1.99
TML	349.28	351.35	29	29	19.71	20.08	324.15	326.13	26	27	22.51	23.01
TFL	344.90	345.85	29	29	19.91	19.73	320.31	321.09	26	27	22.30	22.61
TPB	76.34	77.38	29	28	3.15	3.27	69.60	70.23	25	26	2.83	2.80
TPAB	74.92	75.59	29	28	3.13	3.42	67.73	68.65	25	26	2.69	2.86
TMLD	22.43	24.05	30	29	1.94	1.91	19.78	21.26	26	27	1.47	1.63
TAPD	27.60	26.81	30	29	1.62	1.42	24.20	23.63	26	27	1.32	1.37
FIML	340.69	340.11	27	28	19.10	19.55	315.26	316.87	23	23	20.65	21.66
BIB	273.09		27		12.83		270.50		25		13.64	
IBL	159.82	160.56	27	27	6.19	5.64	153.04	152.57	25	23	7.35	7.69
ACH	54.19	53.75	29	29	2.22	2.25	49.53	49.37	26	25	1.93	2.06
TCH	67.91	67.66	22	25	3.07	3.98	57.59	63.24	16	17	15.65	3.16
TTB	31.44	31.54	24	28	1.29	1.33	28.25	28.48	21	19	1.70	1.44

DONALDSON

Dimension	MALES						FEMALES					
	Mean		<i>n</i>	Std. Dev.		Mean		<i>n</i>	Std. Dev.			
	left	right		left	right	left	right		left	right		
BBH	136.25		4	3.10		140.00		3	2.65			
GBL	183.25		4	3.40		177.00		3	8.66			
EUB	141.00		4	2.16		138.67		3	1.15			
UFH	85.73		4	5.21		77.85		3	5.43			
NAH	35.02		1			31.30		1				
NAW	24.94		4	1.42		25.31		3	0.91			
ZYG	146.50		4	3.70		138.00		3	2.00			
JNB	33.40		3	2.24		26.97		2	0.36			
CML	163.40	164.90	5	5	7.12	9.45	143.17	144.67	3	3	4.31	9.07
CAPD	12.05	12.31	5	5	0.95	0.97	10.04	10.36	3	3	0.32	0.53
CSID	10.40	10.88	5	5	0.95	0.71	8.72	9.52	3	3	0.46	0.86
C1	10.50		1			11.79		3	1.21			
XC2	39.67		4	1.88		34.80		4	1.01			
XC3	13.57		4	2.17		11.73		4	1.04			
XC4	12.63		4	1.63		10.90		3	0.70			
XC5	12.15		4	1.19		11.23		3	1.12			
XC6	13.16		3	1.37		11.69		4	0.88			
XC7	14.80		3	0.97		13.53		4	0.60			
XT1	17.15		3	1.71		15.74		4	0.41			
XT2	19.11		3	1.63		16.75		4	0.73			
XT3	18.85		3	1.80		17.26		4	0.46			
XT4	20.14		3	1.53		17.37		5	0.99			
XT5	19.95		4	0.62		17.78		3	0.92			
XT6	21.24		4	0.50		18.14		3	0.24			
XT7	20.94		4	0.64		18.96		3	0.67			
XT8	21.88		4	0.71		19.53		4	0.67			
XT9	23.11		4	1.32		20.23		4	1.11			
XT10	22.92		4	1.78		21.29		4	1.48			
XT11	24.55		3	1.48		21.62		4	1.31			
XT12	25.89		3	2.15		23.14		4	1.88			
XL1	27.32		4	1.79		25.54		5	1.33			
XL2	28.07		4	1.79		26.20		5	1.31			
XL3	28.94		4	1.62		27.61		5	1.75			
XL4	29.77		4	1.54		27.93		5	1.77			

DONALDSON, CONTINUED

Dimension	MALES						FEMALES					
	Mean		<i>n</i>	Std. Dev.		Mean		<i>n</i>	Std. Dev.			
	left	right		left	right	left	right		left	right		
XL5	31.35		4	0.89		28.09		5	0.92			
S1	32.51		4	0.95		30.22		5	1.72			
SML	120.86		3	3.52		109.87		2	12.95			
HML	349.40	352.30	5	5	8.50	8.11	319.40	326.20	5	5	18.35	16.47
HEB	63.80	64.00	5	4	3.11	2.68	57.30	58.00	5	5	1.40	3.34
HHD	46.46	46.44	5	5	3.14	3.48	41.97	42.52	5	5	1.64	1.88
HMLD	24.12	25.31	5	5	1.38	1.30	19.90	20.26	5	5	2.26	2.20
HAPD	24.69	25.85	5	5	1.42	1.55	19.07	20.68	5	5	2.50	1.84
HAB	45.71	46.54	5	5	2.21	2.14	40.56	40.38	5	5	1.23	1.49
RML	271.88	280.00	4	3	9.73	1.73	245.60	248.13	5	4	10.51	15.09
RMLD	16.07	15.87	4	4	1.30	1.01	13.69	14.34	5	5	1.47	1.77
RAPD	12.72	12.80	4	4	0.27	0.67	10.87	11.00	5	5	0.29	0.68
RMLH	22.35	23.38	4	3	1.00	1.13	20.82	20.56	4	4	0.52	0.83
RAPH	23.30	24.12	4	3	1.00	0.78	21.18	21.30	4	4	0.57	1.00
RAB	28.06	29.00	3	4	2.25	1.83	24.91	25.98	5	5	1.04	1.43
UML	299.67	292.17	3	3	7.49	7.52	270.13	269.60	4	5	9.54	9.45
UMLD	13.30	14.60	4	3	0.75	1.37	11.00	11.74	4	5	0.68	0.88
UAPD	18.07	17.85	4	3	0.51	1.37	13.30	15.02	4	5	1.68	1.81
FML	491.00	489.00	4	4	15.71	15.38	449.50	454.40	4	5	18.14	22.49
FBL	488.38	485.38	4	4	16.42	15.91	445.38	450.00	4	5	19.50	23.87
FEB	84.13	84.40	4	5	3.04	3.05	76.50	76.75	3	4	1.32	3.57
FAB	74.99	74.21	4	5	2.24	1.99	67.08	67.08	3	4	0.65	3.15
FHD	47.37	47.31	4	5	2.67	2.35	43.45	43.77	4	5	1.64	1.24
FMLD	29.74	29.61	4	4	1.60	1.27	25.98	26.44	4	5	1.49	1.80
FAPD	32.42	32.56	4	4	1.17	1.50	25.71	27.55	4	5	1.43	3.31
TML	411.25	413.90	4	5	14.20	15.99	381.83	381.25	3	4	11.25	25.31
TFL	407.25	410.00	4	5	12.69	15.13	378.33	378.00	3	4	12.50	25.22
TPB	77.67	79.30	3	5	1.53	2.05	74.00	73.83	3	3	2.18	4.19
TPAB	75.96	76.80	4	5	1.66	2.39	71.47	71.80	3	3	2.25	3.99
TMLD	23.31	26.74	4	5	0.60	1.41	21.06	23.09	3	4	0.99	0.94
TAPD	30.00	29.37	4	5	1.10	1.46	27.27	26.84	3	4	1.50	1.53
FIML	393.50	406.00	2	1	4.95			370.25		2		27.93
BIB	295.88		4		8.25		281.25		4		21.87	
IBL	164.75	165.75	4	4	3.40	4.35	168.50	168.00	2	3	9.19	10.44
ACH	53.88	53.11	5	5	2.80	2.13	48.73	49.42	3	4	3.03	2.97
TCH	69.75	71.50	4	4	3.77	3.42	63.50	63.67	2	3	0.71	1.53
TTB	32.15	32.25	4	4	0.75	0.65	29.69	29.02	3	3	0.48	1.09

ALTAR DE SACRIFICIOS

Dimension	MALES					FEMALES					
	Mean		n	Std. Dev.		Mean		n	Std. Dev.		
	left	right		left	right	left	right		left	right	
BBH	134.80		5	2.77		134.50		2	4.95		
GBL	171.00		5	3.87		168.00		2	15.56		
EUB	149.20		5	4.21		136.00		2	15.56		
UFH	85.39		4	4.67		78.51		2	0.41		
NAH	28.22		4	2.51		26.00		1			
NAW	25.25		5	2.43		24.45		1			
ZYG	145.00		4	3.16		135.00		2	5.66		
JNB	26.28		2	0.70		22.56		1			
CML	148.75	150.33	2	3	5.30	2.08	126.00	125.00	1	2	5.66
CAPD	16.90	12.54	2	3	3.23	0.15	8.19	8.59	1	2	0.14
CSID	12.00	10.56	2	3	2.49	1.07	7.72	7.72	1	2	0.18
C1	12.66		2	0.20		10.09		3	1.32		
XC2	35.23		2	0.86		32.08		3	1.08		
XC3	13.28		2	1.02		11.47		3	1.97		
XC4	13.75		1			11.53		3	1.35		
XC5	13.50		1			10.45		2	0.45		
XC6	12.90		1			10.93		2	0.44		
XC7	14.47		1			12.56		2	0.29		
XT1						13.90		2	0.70		
XT2						15.85		2	0.77		
XT3						15.29		2	1.23		
XT4	17.93		2	1.24		16.05		2	0.01		
XT5	18.17		1			15.89		2	0.34		
XT6	18.52		2	0.30		16.61		2	0.62		
XT7	20.01		2	0.71		17.79		3	1.35		
XT8	19.48		1			18.19		3	1.50		
XT9	20.49		2	0.21		19.24		3	1.03		
XT10	21.42		3	0.41		20.27		3	0.73		
XT11	22.25		3	0.54		20.50		3	1.01		
XT12	23.91		2	0.29		22.45		3	0.91		
XL1	25.14		2	0.11		23.54		3	1.45		
XL2	25.92		2	0.31		24.10		3	1.44		
XL3	26.70		2	0.74		25.45		3	1.27		
XL4	27.68		3	0.80		26.39		3	1.55		

ALTAR DE SACRIFICIOS, CONTINUED

Dimension	MALES						FEMALES					
	Mean		n		Std. Dev.		Mean		n		Std. Dev.	
	left	right			left	right	left	right			left	right
XL5	29.21		5		2.01		26.55		3		1.86	
S1	30.15		4		2.09		27.69		4		3.61	
SML	114.60		2		8.11							
HML	310.25	328.33	6	6	17.17	14.81	277.17	277.67	3	3	3.62	4.04
HEB	60.42	61.85	6	10	3.47	2.74	51.25	52.00	4	4	1.85	2.68
HHH	44.99	45.46	6	6	2.95	3.77	37.55	36.85	3	2	0.68	2.45
HMLD	20.10	20.72	6	6	1.57	0.77	16.37	15.94	3	3	1.85	0.96
HAPD	19.74	19.91	6	6	1.14	1.49	18.80	17.72	3	3	1.99	1.81
HAB	42.43	43.18	5	10	2.31	1.67	35.91	35.82	4	4	0.86	0.89
RML	240.00	244.33	6	6	14.66	13.17	218.25	219.25	2	4	10.25	4.99
RMLD	13.30	13.71	6	6	0.91	1.27	12.14	13.19	2	4	3.05	1.43
RAPD	11.67	12.07	6	6	1.15	1.35	9.66	9.88	2	4	0.35	1.23
RMLH	20.97	20.93	4	6	0.99	1.36	17.54	17.95	3	4	0.47	1.14
RAPH	21.62	21.44	4	6	0.63	1.17	18.42	18.75	3	4	0.45	1.12
RAB	24.32	25.21	6	6	1.95	1.14	23.84	23.54	2	4	2.62	1.40
UML	267.00	268.75	5	4	9.23	11.00	231.33	233.75	3	4	8.74	7.63
UMLD	12.95	12.83	5	4	1.31	1.56	10.62	11.32	3	4	0.64	0.38
UAPD	15.34	15.69	5	4	0.84	1.30	13.54	13.33	3	4	0.50	0.76
FML	441.70	435.63	5	8	25.25	31.70	387.50	384.83	2	3	7.07	2.84
FBL	439.00	432.81	5	8	24.10	30.43	385.00	381.00	2	3	8.49	5.20
FEB	80.38	83.00	4	5	0.95	3.41	70.00	69.75	3	4	2.78	3.48
FAB	69.49	70.88	4	6	3.05	2.81	59.45	60.75	3	4	2.16	3.92
FHD	43.61	44.73	7	9	2.28	2.97	38.92	38.88	4	4	1.28	1.59
FMLD	27.33	26.09	5	8	2.57	1.28	24.68	23.24	2	3	0.93	0.65
FAPD	29.64	30.03	5	8	2.42	2.50	22.71	24.37	2	3	2.26	2.73
TML	365.58	377.25	6	6	24.93	19.49	325.00	337.00	2	2	15.56	5.66
TFL	361.37	373.08	6	6	24.11	19.69	321.00	334.50	2	2	19.09	7.78
TPB	74.63	77.13	4	4	1.38	1.38	66.00	66.17	3	3	1.00	1.26
TPAB	72.22	74.40	4	4	2.10	1.59	63.82	64.27	3	3	0.37	0.61
TMLD	20.97	21.79	6	6	1.48	1.74	17.81	19.03	2	2	1.91	1.65
TAPD	27.55	28.26	6	6	2.23	2.08	24.20	23.34	2	2	1.27	0.16
FIML	349.00		1					319.33		3		17.56
BIB	272.33		3		8.62		251.00		2		1.41	
IBL	152.67	151.00	3	3	5.03	2.83	136.00	138.00	1	1		
ACH	51.02	48.54	4	4	3.93	3.48	45.07	45.09	4	4	2.62	2.67
TCH	64.50	65.60	7	7	3.64	3.42	56.50	58.83	1	3		1.53
TTB	30.15	30.33	7	7	1.08	1.50	26.33	26.06	2	3	0.75	0.74

AYALÁN

Dimension	MALES			FEMALES							
	Mean		n	Std. Dev.		Mean		n	Std. Dev.		
	left	right		left	right	left	right		left	right	
BBH	131.00		2	1.41		128.00		6	3.29		
GBL	169.67		3	4.04		163.50		6	5.24		
EUB	145.00		3	9.54		139.17		6	3.43		
UFH	79.38		2	2.35		74.59		2	4.40		
NAH	26.40		3	2.62		25.39		2	3.27		
NAW	23.19		3	0.52		22.08		2	2.02		
ZYG	148.00		1			133.60		5	2.30		
JNB						23.90		1			
CML		137.00	2		7.07	136.33	133.00	3	3	9.71	5.29
CAPD		13.76	2		0.49	9.52	9.74	3	3	0.91	0.34
CSID		10.91	2		0.28	8.43	8.54	3	3	0.14	0.84
C1	9.46		2	0.64		8.40		5	0.66		
XC2	33.58		4	1.61		30.70		5	3.34		
XC3	12.84		4	1.00		10.58		5	1.48		
XC4	12.60		4	0.94		10.84		5	0.84		
XC5	12.18		4	0.93		10.72		5	0.70		
XC6	11.93		4	0.39		10.88		5	0.46		
XC7	13.75		4	0.71		12.41		5	0.56		
XT1	15.84		4	1.68		14.42		5	0.53		
XT2	17.33		4	1.05		15.78		5	0.71		
XT3	17.29		4	1.42		16.27		5	0.53		
XT4	17.93		4	1.37		16.85		5	0.38		
XT5	18.96		4	1.32		17.48		5	0.48		
XT6	19.35		4	1.55		17.53		5	1.03		
XT7	19.11		4	1.81		18.10		5	1.35		
XT8	19.81		4	0.83		18.57		5	1.27		
XT9	21.21		4	0.75		19.02		5	1.59		
XT10	22.09		4	0.59		20.34		5	1.30		
XT11	22.46		4	1.01		20.44		5	1.41		
XT12	24.28		4	0.53		22.92		5	1.78		
XL1	25.99		4	0.46		23.74		5	1.21		
XL2	26.08		4	1.22		24.91		5	1.08		
XL3	25.83		4	0.89		25.04		5	1.30		
XL4	26.93		4	1.37		25.77		5	1.27		

AYALÁN, CONTINUED

Dimension	MALES						FEMALES					
	Mean		n	Std. Dev.		Mean		n	Std. Dev.			
	left	right		left	right	left	right		left	right		
XL5	27.81		4	1.72		25.87		5	1.03			
S1	29.38		4	2.38		27.30		5	2.00			
SML	105.58		1			99.23		2	8.51			
HML	305.50	304.17	4	3	15.02	13.79	275.67	273.50	3	4	31.01	25.69
HEB	60.75	61.50	4	4	2.53	2.65	51.50	52.00	5	5	3.62	3.95
HHD	43.76	43.85	4	4	1.30	2.15	36.59	36.28	5	4	1.59	1.50
HMLD	21.13	22.62	4	3	1.09	0.81	18.36	19.25	3	4	0.92	1.01
HAPD	19.76	20.87	4	3	1.11	1.35	17.59	17.68	3	4	0.66	1.23
HAB	40.90	42.24	4	4	2.42	1.75	36.44	35.94	5	5	2.15	2.28
RML	242.00	239.00	3	2	7.81	1.41	221.83	217.00	3	5	11.03	12.43
RMLD	14.01	14.60	3	3	1.92	1.85	13.73	13.25	3	5	0.99	1.55
RAPD	11.25	11.92	3	3	0.31	0.39	10.18	10.24	3	5	0.79	0.93
RMLH	21.05	21.77	3	3	1.11	1.54	18.27	18.89	4	5	1.14	0.89
RAPH	21.25	22.64	3	3	1.53	1.61	19.11	18.88	4	5	1.59	1.12
RAB	24.12	23.88	3	2	0.02	1.07	22.79	23.19	4	5	1.36	0.93
UML		256.00		2		2.83	227.50	234.88	2	4	10.61	14.39
UMLD		12.74		2		0.43	11.55	12.52	2	4	0.40	1.34
UAPD		14.80		2		1.45	12.62	12.49	2	4	1.80	0.74
FML	426.63	428.67	4	3	10.50	12.50	384.70	398.83	5	3	25.60	20.89
FBL	419.67	425.50	3	3	6.43	13.03	379.20	394.17	5	3	27.34	21.62
FEB	76.83	77.00	3	4	2.36	3.37	68.67	67.50	3	3	2.31	2.65
FAB	66.55	66.57	3	4	3.78	3.39	58.43	57.75	3	3	1.58	2.12
FHD	43.66	43.58	4	4	1.58	1.41	38.28	38.34	5	5	1.12	0.85
FMLD	27.03	26.61	4	3	1.65	1.85	23.02	23.23	5	3	2.59	1.54
FAPD	27.66	29.29	4	3	2.29	1.12	23.41	23.68	5	3	2.39	1.89
TML	360.67	356.00	3	3	16.29	14.11	327.25	326.50	4	4	20.32	19.03
TFL	357.33	352.50	3	3	15.14	12.82	323.63	322.88	4	4	19.82	18.97
TPB	72.00	71.50	3	3	4.27	4.92	63.17	63.75	3	4	1.61	2.90
TPAB	68.84	68.99	3	3	3.14	4.63	61.71	61.16	3	4	0.14	2.53
TMLD	21.04	22.28	3	3	0.89	1.77	18.71	21.02	4	4	1.95	2.61
TAPD	28.19	26.56	3	3	0.42	1.45	23.67	24.66	4	4	1.71	2.14
FIML							297.50	296.00	1	1		
BIB	245.00		1			243.17		3	12.29			
IBL		149.00		1			144.50	141.50	2	2	3.54	3.54
ACH	46.34	47.24	1	2		0.24	43.50	43.65	3	2	2.10	2.05
TCH	66.25	65.25	2	4	1.77	2.87	52.00	55.00	1	4		1.96
TTB	29.30	28.99	3	4	1.57	1.99	23.69	24.62	3	4	1.97	1.91

ANCON

Dimension	MALES						FEMALES					
	Mean		n	Std. Dev.		Mean		n	Std. Dev.			
	left	right		left	right	left	right		left	right		
BBH	131.08		26	5.32		125.00		33	5.68			
GBL	164.89		26	6.06		158.83		23	5.69			
EUB	150.62		26	7.37		144.83		23	8.79			
UFH	79.82		25	5.06		75.71		23	3.68			
NAH	31.17		25	1.98		28.35		23	2.19			
NAW	23.20		26	1.76		22.46		23	1.50			
ZYG	138.42		26	5.09		128.78		23	4.81			
JNB	24.08		20	2.74		21.14		14	3.09			
CML	150.55	148.73	21	20	6.09	5.65	132.46	130.57	14	14	7.53	7.34
CAPD	11.63	11.89	21	20	1.75	1.37	9.74	9.94	14	14	1.03	1.16
CSID	9.93	10.19	21	19	1.03	1.35	7.78	7.96	14	14	0.58	0.80
C1	10.52		20	1.32		9.48		16	1.58			
XC2	37.40		20	2.63		34.17		16	2.30			
XC3	13.77		20	0.97		12.03		15	0.99			
XC4	13.64		20	1.31		11.97		15	0.95			
XC5	12.26		20	1.45		11.50		15	1.16			
XC6	12.15		20	1.21		11.47		16	0.92			
XC7	14.06		20	0.79		12.88		16	0.95			
XT1	16.25		20	0.58		14.72		17	1.03			
XT2	18.07		20	1.10		16.45		17	0.87			
XT3	17.96		20	1.10		16.59		17	1.05			
XT4	18.52		20	1.08		16.77		17	1.05			
XT5	19.37		20	1.02		17.17		17	1.40			
XT6	19.92		20	1.15		17.42		17	1.59			
XT7	20.41		20	1.21		18.64		17	3.57			
XT8	20.71		20	1.05		18.28		16	1.46			
XT9	21.28		20	1.17		18.85		17	1.65			
XT10	21.86		20	0.97		19.73		17	1.70			
XT11	22.97		19	1.03		20.41		17	1.55			
XT12	24.24		19	1.19		21.77		16	1.49			
XL1	25.54		19	1.28		23.64		16	1.36			
XL2	25.83		19	1.42		24.02		17	1.61			
XL3	26.40		19	1.52		24.97		16	1.39			
XL4	26.70		19	1.67		25.27		15	1.19			

ANCON, CONTINUED

Dimension	MALES						FEMALES					
	Mean		n		Std. Dev.		Mean		n		Std. Dev.	
	left	right			left	right	left	right			left	right
XL5	26.70		19		1.62		25.72		15		1.28	
S1	28.56		21		2.25		26.62		14		2.35	
SML	108.01		21		10.74		97.27		14		9.88	
HML	298.52	298.52	28	27	11.42	10.81	270.70	275.33	23	21	13.49	14.12
HEB	59.61	59.61	28	27	3.26	3.01	53.54	53.76	23	21	3.21	3.31
HHD	43.82	43.82	28	27	2.37	2.27	38.23	38.31	23	21	2.22	2.40
HMLD	20.47	20.47	28	27	1.58	2.03	17.13	17.86	22	19	1.57	1.48
HAPD	19.33	19.33	28	27	1.37	1.51	17.63	17.93	22	19	1.57	1.61
HAB	41.39	41.39	28	26	2.06	2.41	37.16	37.21	23	21	2.27	2.20
RML	232.78	232.78	27	27	11.09	10.68	211.93	211.81	21	21	12.06	13.23
RMLD	14.11	14.11	27	27	1.24	1.02	13.19	13.56	21	21	1.22	0.90
RAPD	11.35	11.35	27	27	0.90	0.86	9.93	9.91	21	21	0.80	0.85
RMLH	20.98	20.98	27	28	1.27	1.07	18.89	19.05	21	21	1.32	1.36
RAPH	21.86	21.86	27	28	1.24	1.27	19.37	19.50	21	21	1.40	1.30
RAB	24.88	24.88	27	27	1.46	1.56	22.42	22.35	21	22	1.33	1.52
UML	251.54	251.54	28	26	9.91	9.80	230.00	230.33	21	20	12.45	13.06
UMLD	12.37	12.37	27	26	1.01	0.94	10.68	10.87	21	20	1.11	0.99
UAPD	15.14	15.14	27	26	1.07	1.09	12.83	13.23	21	20	1.37	1.15
FML	417.36	417.36	28	27	16.39	14.64	382.22	383.07	23	21	18.49	18.00
FBL	413.86	413.86	28	27	16.74	15.07	377.96	379.41	23	21	18.81	18.02
FEB	79.39	79.39	28	27	3.94	4.24	71.13	71.39	23	23	3.65	3.93
FAB	70.58	70.58	28	27	3.14	2.84	61.81	62.34	23	23	3.67	3.51
FHD	45.89	45.89	28	28	2.73	3.02	40.73	40.59	22	21	2.25	2.18
FMLD	27.20	27.20	28	27	1.56	1.98	23.96	23.63	23	21	1.55	1.63
FAPD	27.26	27.26	28	27	1.75	1.47	23.38	23.89	23	21	2.29	2.32
TML	353.59	353.59	28	27	17.70	16.48	328.82	326.89	22	23	16.02	16.51
TFL	349.04	349.04	28	27	17.87	16.46	325.27	323.30	22	23	15.86	16.56
TPB	75.59	75.59	28	27	3.36	3.41	67.09	67.54	22	23	3.59	3.56
TPAB	73.03	73.03	28	27	3.24	3.13	65.06	65.73	22	23	3.61	3.62
TMLD	21.41	21.41	28	26	1.87	1.63	18.71	19.55	22	23	1.24	1.57
TAPD	27.48	27.48	28	26	2.22	1.93	22.80	23.31	22	23	1.94	1.69
FIML	345.79	345.79	26	26	16.56	15.95	320.63	317.94	20	23	15.80	14.95
BIB	269.18		22		13.90		257.73		15		9.40	
IBL	152.85	152.85	27	28	7.11	7.16	144.32	143.19	22	21	5.73	4.98
ACH	50.58	50.58	28	28	2.90	2.95	45.64	45.44	22	22	2.38	2.00
TCH	63.79	63.79	14	16	3.79	3.84	56.83	58.19	12	13	3.14	2.33
TTB	29.45	29.45	17	17	1.56	1.70	25.86	26.17	13	15	1.02	1.20

ARAMBURU

Dimension	MALES				FEMALES					
	Mean		n	Std. Dev.		Mean		n	Std. Dev.	
	left	right		left	right	left	right		left	right
BBH	136.67		3	4.04		123.00		4	1.63	
GBL	169.67		3	3.79		162.25		4	4.86	
EUB	143.00		3	6.08		142.75		4	5.85	
UFH	86.36		3	4.93		75.71		4	2.10	
NAH	25.75		3	1.46		23.18		4	2.16	
NAW	24.17		3	1.09		22.40		4	0.98	
ZYG	142.00		3	2.65		126.75		4	3.95	
JNB						21.63		1		
CML	153.50	152.25	1	2		0.35	134.00	137.00	1	1
CAPD	11.73	12.05	1	2		0.06	8.33	9.26	1	1
CSID	9.31	8.98	1	2		0.22	7.42	7.98	1	1
C1	9.71		1			10.07		1		
XC2						38.59		1		
XC3						13.41		1		
XC4						12.67		1		
XC5						12.37		1		
XC6	13.91		1			13.40		2	0.18	
XC7	15.18		1			15.12		2	0.13	
XT1	17.53		1			16.11		2	0.95	
XT2	19.31		1			17.06		1		
XT3	19.08		1			16.70		1		
XT4	19.14		1			17.47		1		
XT5	19.59		1			17.23		1		
XT6	20.28		1			18.58		2	0.53	
XT7	20.00		1			18.45		1		
XT8	21.06		1			18.27		1		
XT9	20.80		1			18.94		1		
XT10	22.21		1			19.12		1		
XT11	23.16		1			21.00		1		
XT12	24.91		1			22.69		1		
XL1	27.65		1			24.06		1		
XL2	26.74		1			24.31		1		
XL3	28.34		1			26.05		1		
XL4	29.37		1			26.69		1		

ARAMBURU, CONTINUED

Dimension	MALES						FEMALES					
	Mean		n	Std. Dev.		Mean		n	Std. Dev.			
	left	right		left	right	left	right		left	right		
XL5	30.39		1			28.08		2	1.02			
S1	30.31		2	3.92		28.98		1				
SML	109.45		2	22.37		97.77		1				
HML	295.83	302.75	3	4	11.56	10.53	279.50	281.83	3	3	11.30	11.36
HEB	59.83	59.75	3	4	1.89	1.19	51.83	51.17	3	3	2.84	2.47
HHD	44.15	45.39	3	4	3.81	3.11	37.73	36.95	3	3	2.84	2.24
HMLD	21.11	21.65	3	4	0.12	1.52	15.53	16.18	3	3	0.09	0.33
HAPD	19.67	20.55	3	4	1.44	1.62	16.91	16.91	3	3	0.97	0.24
HAB	42.78	42.60	3	4	2.36	1.99	34.95	34.74	3	3	1.87	1.11
RML	231.33	232.83	3	3	11.02	6.45	208.50	209.75	2	2	10.61	7.42
RMLD	14.27	14.71	3	3	0.84	1.22	12.48	12.07	2	2	0.77	0.49
RAPD	11.96	11.69	3	3	1.41	0.64	9.21	9.62	2	2	0.41	0.23
RMLH	22.18	21.62	3	3	1.37	0.50	18.02	18.89	2	2	0.98	0.30
RAPH	22.37	22.26	3	3	1.19	0.46	18.90	19.64	2	2	0.86	0.44
RAB	25.14	24.45	3	3	0.66	0.43	21.47	21.70	2	2	1.72	1.28
UML	251.75	253.67	4	3	9.18	8.74	227.75	227.75	2	2	13.08	8.13
UMLD	12.02	11.98	4	3	0.89	0.67	9.72	9.67	2	2	0.03	0.33
UAPD	16.81	16.67	4	3	1.40	2.06	12.17	12.09	2	2	1.75	0.42
FML	406.50	404.50	3	3	23.29	23.79	372.00	370.67	3	3	5.20	3.82
FBL	402.83	401.00	3	3	21.77	22.65	368.83	367.17	3	3	5.01	3.33
FEB	79.83	79.33	3	3	6.05	5.69	67.50	67.67	3	3	3.50	3.51
FAB	69.24	69.95	3	3	4.14	4.27	59.28	58.82	3	3	1.85	3.66
FHD	44.21	44.16	3	3	3.24	2.91	38.12	38.11	3	3	1.82	1.52
FMLD	25.10	25.98	3	3	1.48	1.98	23.35	22.81	3	3	2.70	3.05
FAPD	26.84	26.80	3	3	0.77	2.38	21.03	21.17	3	3	1.73	1.74
TML	341.33	342.83	3	3	21.57	21.11	306.83	312.50	3	1	9.39	
TFL	338.00	338.00	3	3	20.48	20.32	304.17	310.00	3	1	9.67	
TPB	75.00	73.83	3	3	2.18	3.40	65.75	62.00	2	1	1.77	
TPAB	73.97	73.08	3	3	2.03	2.78	63.44	60.58	3	1	1.61	
TMLD	21.81	22.59	3	3	1.70	0.42	17.51	17.63	3	1	1.05	
TAPD	28.50	27.77	3	3	1.46	1.65	22.23	20.15	3	1	1.88	
FIML	332.83	330.67	3	3	19.07	19.14	345.75	281.83	2	3	57.63	
BIB	270.75		2	11.67		241.00		1				
IBL	151.50	149.50	2	2	6.36	4.95	139.00	143.00	1	1		
ACH	49.06	48.46	2	2	4.50	3.61	45.01	44.72	1	1		
TCH												
TTB		29.42		1				21.61		1		

NASCA

Dimension	MALES			FEMALES				
	Mean		n	Std. Dev.		n	Std. Dev.	
	left	right		left	right		left	right
BBH	130.36		11	4.86		10	5.69	
GBL	166.00		11	6.23		10	5.60	
EUB	146.73		11	4.86		10	7.56	
UFH	79.59		11	3.57		9	5.71	
NAH	23.55		11	0.60		9	2.06	
NAW	24.50		11	0.97		9	1.24	
ZYG	136.30		10	4.45		8	7.17	
JNB	26.32		1			2	2.20	
CML		155.50	1			2	1	6.01
CAPD		11.40	1			2	1	1.74
CSID		9.99	1			2	1	1.33
C1						2	1.20	
XC2						2	3.59	
XC3						2	1.61	
XC4						2	1.55	
XC5						2	0.95	
XC6						2	0.20	
XC7						2	0.49	
XT1						2	2.24	
XT2						2	0.83	
XT3						2	0.17	
XT4						2	0.76	
XT5						2	0.54	
XT6						2	1.07	
XT7						2	1.65	
XT8						2	1.44	
XT9						2	1.69	
XT10						2	0.82	
XT11	23.00		1			2	0.34	
XT12	23.21		1			2	0.37	
XL1	24.50		1			2	0.90	
XL2	23.34		1			2	0.33	
XL3	27.95		2	2.74		2	0.45	
XL4	28.17		2	0.66		2	0.08	

NASCA, CONTINUED

Dimension	MALES						FEMALES					
	Mean		n		Std. Dev.		Mean		n		Std. Dev.	
	left	right			left	right	left	right			left	right
XL5	27.78		2		3.17		25.50		2		0.03	
S1	28.50		5		2.27		28.50		4		2.06	
SML	105.21		4		7.76		103.55		2		22.60	
HML	306.78	313.00	9	8	19.26	14.31	278.67	284.00	9	7	16.85	18.34
HEB	60.11	61.88	9	8	4.50	4.52	53.56	53.94	9	8	5.04	4.03
HHD	44.38	45.35	9	9	2.42	2.72	38.41	38.44	9	7	3.31	2.85
HMLD	20.45	22.22	9	8	1.86	1.65	17.16	17.90	9	7	1.48	1.25
HAPD	18.53	19.65	9	8	1.53	1.85	16.00	17.11	9	7	1.21	1.47
HAB	41.41	41.23	9	8	1.39	2.43	36.85	37.07	9	8	2.83	2.92
RML	246.58	244.38	6	4	16.79	16.32	217.36	225.90	7	5	20.28	20.51
RMLD	13.71	13.33	6	4	1.07	1.83	12.42	12.17	7	5	0.87	1.43
RAPD	11.18	11.64	6	4	0.95	0.81	9.64	9.56	7	5	0.93	1.11
RMLH	20.94	20.91	6	5	1.79	1.11	18.13	18.42	7	8	1.72	1.46
RAPH	21.52	22.11	6	5	1.78	1.28	18.69	18.86	7	8	1.87	1.56
RAB	24.67	24.74	5	4	1.93	1.76	20.98	21.55	7	6	2.18	2.41
UML	261.50	262.00	6	3	16.16	20.42	241.17	242.70	6	5	18.13	19.70
UMLD	12.17	12.35	6	3	1.20	0.75	10.11	10.95	6	5	0.60	0.97
UAPD	13.44	13.10	6	3	1.03	1.38	13.04	11.66	6	5	1.08	2.35
FML	422.65	423.17	10	9	17.55	16.60	395.71	387.69	7	8	20.69	25.32
FBL	420.15	418.75	10	8	17.34	17.22	391.14	383.81	7	8	21.26	24.56
FEB	78.75	79.69	10	8	3.39	3.60	73.21	72.28	7	9	5.11	5.38
FAB	67.53	68.26	10	8	3.25	3.36	61.40	60.28	7	9	4.19	4.73
FHD	44.94	44.89	10	8	2.18	2.29	40.08	39.95	9	8	2.71	2.93
FMLD	26.50	26.38	10	9	2.26	2.43	23.46	23.55	7	8	2.11	1.27
FAPD	28.08	28.43	10	9	2.28	1.90	24.31	23.64	7	8	1.97	2.72
TML	368.06	366.31	9	8	16.64	22.47	332.44	332.07	8	7	22.89	24.03
TFL	363.06	361.25	9	8	16.42	22.70	329.56	329.75	8	8	22.80	22.97
TPB	73.85	74.44	10	9	3.24	3.38	68.00	66.50	7	8	4.57	4.67
TPAB	71.25	72.11	10	9	3.41	3.67	66.19	64.45	7	8	4.24	4.97
TMLD	22.40	23.11	9	8	1.98	2.32	19.10	20.06	8	8	1.47	1.34
TAPD	27.92	27.77	9	8	1.54	2.08	23.84	24.39	8	8	2.65	2.30
FIML	349.90	342.13	5	4	18.54	27.74	332.25	310.75	4	2	7.08	46.32
BIB	274.38		4		26.20		264.88		4		23.64	
IBL	151.60	152.25	5	4	9.13	11.21	143.67	145.33	3	3	16.62	18.50
ACH	49.81	49.18	6	5	3.03	4.21	45.43	45.34	4	4	4.13	4.42
TCH	66.00		1				59.75	61.00	2	2	5.30	4.24
TTB	31.95		1				27.16	27.46	2	2	1.09	0.43

CERRO AZUL & CERRO DEL ORO

Dimension	MALES			FEMALES				
	Mean		n	Std. Dev.		n	Std. Dev.	
	left	right		left	right		left	right
BBH	126.43		7	5.38				
GBL	167.43		7	4.20				
EUB	152.14		7	11.13				
UFH	80.64		7	4.65				
NAH	24.13		7	1.01				
NAW	23.69		7	0.95				
ZYG	138.00		7	7.12				
JNB								
CML								
CAPD								
CSID								
C1								
XC2								
XC3								
XC4								
XC5								
XC6								
XC7								
XT1								
XT2								
XT3								
XT4								
XT5								
XT6								
XT7								
XT8								
XT9								
XT10								
XT11								
XT12								
XL1								
XL2								
XL3								
XL4								

CERRO AZUL & CERRO DEL ORO, CONTINUED

Dimension	MALES						FEMALES						
	Mean		n		Std. Dev.		Mean		n		Std. Dev.		
	left	right			left	right	left	right			left	right	
XL5													
S1													
SML													
HML	282.17	288.64	6	7	13.85	12.27							
HEB	56.83	58.07	6	7	3.39	3.27							
HHD	41.24	41.81	6	7	2.86	2.65							
HMLD	19.38	20.20	6	7	1.80	1.13							
HAPD	19.40	19.58	6	7	0.85	0.97							
HAB	40.20	39.75	6	7	2.33	1.92							
RML	208.50	228.75	1	4		7.19							
RMLD	12.60	14.47	1	4		0.77							
RAPD	11.39	10.87	1	4		0.54							
RMLH	20.55	20.21	1	4		0.86							
RAPH	20.92	20.81	1	4		0.87							
RAB	25.34	24.32	1	4		0.93							
UML	247.17	240.50	3	2	9.12	4.95							
UMLD	11.91	11.43	3	2	0.48	0.04							
UAPD	14.45	15.46	3	2	1.42	1.61							
FML	411.14	409.21	7	7	18.61	19.91							
FBL	406.86	405.00	7	7	19.64	20.28							
FEB	78.36	78.93	7	7	2.19	2.28							
FAB	67.99	68.36	7	7	3.25	3.31							
FHD	44.22	43.93	7	7	1.44	1.61							
FMLD	24.31	24.36	7	7	1.18	0.97							
FAPD	27.02	26.64	7	7	1.88	1.71							
TML	341.86	341.83	7	6	17.76	18.33							
TFL	338.00	337.75	7	6	18.51	18.03							
TPB	73.71	73.64	7	7	2.97	2.84							
TPAB	71.24	71.71	7	7	2.30	2.86							
TMLD	21.09	21.57	7	6	0.87	1.12							
TAPD	26.03	25.57	7	6	1.61	1.50							
FIML	335.17	342.50	3	2	11.07	7.78							
BIB													
IBL	154.00	150.00	1	2		2.83							
ACH	48.07	48.42	1	2		0.07							

**HUMAN SKELETAL VARIATION IN THE NEW WORLD DURING
THE HOLOCENE: EFFECTS OF CLIMATE AND SUBSISTENCE
ACROSS GEOGRAPHY AND TIME – PART III**

by

Benjamin Miller Auerbach

A dissertation submitted to Johns Hopkins University in conformity with the
requirements for the degree of Doctor of Philosophy.

Baltimore, Maryland, United States of America

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Appendix V. Part B. Derived morphology descriptive statistics, by sample and sex.
(See Appendix III for measurement abbreviations, units and definitions.)

PRE-ALEUT

Dimension	Mean	N	Std. Dev.
MALES			
Cranial index	78.33	12	2.65
Cranial module	152.64	11	3.19
Facial index	167.42	10	10.17
Nasal index	90.18	12	5.55
Relative torso height	48.43	8	1.60
Brachial index	77.18	12	2.81
Crural index	81.61	13	2.08
Relative upper limb/ torso height	148.46	8	6.38
Interlimb index	71.60	12	1.06
Upper body width	337.72	8	11.43
Bi-iliac breadth	276.88	12	10.13
Lower limb length	759.96	13	38.03
Stature (Fully)	156.77	7	3.61
Body Mass (FHD)	68.03	13	3.57
FEMALES			
Cranial index	79.73	13	4.98
Cranial module	148.77	13	3.64
Facial index	164.93	12	9.86
Nasal index	90.92	13	9.25
Relative torso height	52.26	6	1.82
Brachial index	74.53	15	2.66
Crural index	82.08	13	2.13
Relative upper limb/ torso height	135.29	7	4.78
Interlimb index	70.38	12	1.61
Upper body width	305.30	9	23.79
Bi-iliac breadth	270.85	13	15.77
Lower limb length	700.66	13	18.22
Stature (Fully)	149.63	6	3.78
Body Mass (FHD)	57.89	15	3.73

NEO-ALEUT

Dimension	Mean	N	Std. Dev.
MALES			
Cranial index	82.56	26	3.15
Cranial module	151.54	26	3.36
Facial index	166.09	26	8.69
Nasal index	85.81	26	8.60
Relative torso height	49.04	20	2.59
Brachial index	76.29	29	1.75
Crural index	81.20	36	1.66
Relative upper limb/ torso height	144.61	18	7.04
Interlimb index	71.31	29	1.37
Upper body width	334.71	19	13.09
Bi-iliac breadth	262.99	35	13.37
Lower limb length	746.09	36	47.95
Stature (Fully)	159.31	17	6.63
Body Mass (FHD)	66.63	36	4.75
FEMALES			
Cranial index	83.08	19	3.79
Cranial module	148.28	19	3.80
Facial index	163.38	19	12.14
Nasal index	89.65	19	13.01
Relative torso height	51.48	12	2.42
Brachial index	74.59	19	2.26
Crural index	81.09	18	1.70
Relative upper limb/ torso height	139.41	12	7.32
Interlimb index	70.87	16	2.24
Upper body width	304.40	15	17.52
Bi-iliac breadth	259.47	18	10.60
Lower limb length	690.42	18	39.65
Stature (Fully)	147.18	10	2.89
Body Mass (FHD)	57.13	20	5.46

IKOGMIUT

Dimension	Mean	N	Std. Dev.
MALES			
Cranial index	77.56	26	3.43
Cranial module	152.12	26	3.90
Facial index	160.38	26	12.80
Nasal index	81.72	27	11.73
Relative torso height	47.95	20	3.13
Brachial index	74.70	27	2.67
Crural index	82.49	29	2.16
Relative upper limb/ torso height	149.26	19	7.44
Interlimb index	71.60	27	1.54
Upper body width	330.45	15	16.14
Bi-iliac breadth	264.85	27	16.23
Lower limb length	766.68	29	46.43
Stature (Fully)	158.17	18	7.44
Body Mass (FHD)	67.21	29	5.13
FEMALES			
Cranial index	78.02	31	3.60
Cranial module	144.81	31	2.85
Facial index	161.56	31	15.38
Nasal index	87.59	31	9.07
Relative torso height	48.74	21	2.94
Brachial index	72.91	30	2.84
Crural index	80.55	31	1.78
Relative upper limb/ torso height	143.74	21	8.63
Interlimb index	69.76	30	1.43
Upper body width	298.81	14	17.37
Bi-iliac breadth	259.00	30	14.07
Lower limb length	711.52	31	32.70
Stature (Fully)	148.29	21	4.20
Body Mass (FHD)	57.38	31	4.91

KUSKOWAGAMIUT

Dimension	Mean	N	Std. Dev.
MALES			
Cranial index	77.34	13	3.50
Cranial module	151.51	13	5.29
Facial index	160.48	13	8.35
Nasal index	82.86	13	8.59
Relative torso height	48.31	10	3.35
Brachial index	74.72	13	1.52
Crural index	79.37	14	2.29
Relative upper limb/ torso height	149.76	9	10.69
Interlimb index	71.81	13	0.66
Upper body width	326.80	5	15.25
Bi-iliac breadth	265.11	14	13.99
Lower limb length	749.35	14	25.42
Stature (Fully)	156.75	9	3.00
Body Mass (FHD)	67.63	14	5.03
FEMALES			
Cranial index	79.20	12	2.27
Cranial module	145.72	12	3.03
Facial index	167.08	12	12.09
Nasal index	90.05	12	8.17
Relative torso height	46.75	12	0.63
Brachial index	72.86	12	2.67
Crural index	80.71	14	1.38
Relative upper limb/ torso height	149.52	11	2.99
Interlimb index	69.90	12	1.16
Upper body width	301.26	9	19.15
Bi-iliac breadth	254.50	14	13.00
Lower limb length	711.90	14	32.66
Stature (Fully)	147.51	11	4.22
Body Mass (FHD)	57.55	14	5.48

POINT BARROW

Dimension	Mean	N	Std. Dev.
MALES			
Cranial index	70.29	17	2.31
Cranial module	151.43	17	4.08
Facial index	162.86	17	8.97
Nasal index	73.22	18	8.98
Relative torso height	44.41	9	2.40
Brachial index	75.03	15	2.64
Crural index	81.97	15	2.61
Relative upper limb/ torso height	155.85	10	6.59
Interlimb index	69.26	14	1.37
Upper body width	322.95	9	16.34
Bi-iliac breadth	275.35	13	14.16
Lower limb length	776.97	15	40.85
Stature (Fully)	156.74	9	6.77
Body Mass (FHD)	69.57	16	4.77
FEMALES			
Cranial index	71.45	8	3.83
Cranial module	144.79	8	4.56
Facial index	159.39	7	8.97
Nasal index	76.79	8	12.59
Relative torso height	46.98	3	2.04
Brachial index	73.93	5	4.57
Crural index	83.04	5	2.30
Relative upper limb/ torso height	146.04	4	6.64
Interlimb index	68.87	3	1.29
Upper body width	292.54	4	13.60
Bi-iliac breadth	256.08	6	16.40
Lower limb length	728.95	5	31.88
Stature (Fully)	149.22	3	7.15
Body Mass (FHD)	55.55	7	10.07

POINT HOPE - IPIUTAK

Dimension	Mean	N	Std. Dev.
MALES			
Cranial index	76.09	18	2.26
Cranial module	150.24	18	2.99
Facial index	161.00	18	6.74
Nasal index	82.80	16	9.21
Relative torso height	47.18	14	1.76
Brachial index	75.40	19	2.41
Crural index	81.21	19	2.57
Relative upper limb/ torso height	150.59	14	6.08
Interlimb index	71.23	19	1.45
Upper body width	307.79	8	15.39
Bi-iliac breadth	274.83	15	13.47
Lower limb length	749.63	19	47.96
Stature (Fully)	154.32	13	7.85
Body Mass (FHD)	67.59	19	3.72
FEMALES			
Cranial index	77.49	14	2.56
Cranial module	146.50	14	3.96
Facial index	161.65	13	9.88
Nasal index	83.29	10	8.41
Relative torso height	48.68	11	2.09
Brachial index	71.63	15	2.23
Crural index	80.20	16	1.50
Relative upper limb/ torso height	144.72	11	5.05
Interlimb index	70.52	15	2.75
Upper body width	284.67	6	6.15
Bi-iliac breadth	268.32	14	11.87
Lower limb length	694.58	16	29.08
Stature (Fully)	146.36	11	3.27
Body Mass (FHD)	56.90	16	5.11

POINT HOPE - TIGARA

Dimension	Mean	N	Std. Dev.
MALES			
Cranial index	72.76	20	3.81
Cranial module	153.57	20	4.47
Facial index	163.45	20	9.07
Nasal index	78.44	15	8.08
Relative torso height	46.50	17	3.26
Brachial index	74.91	22	2.31
Crural index	82.86	22	2.01
Relative upper limb/ torso height	146.00	17	9.77
Interlimb index	67.71	22	1.32
Upper body width	316.77	11	14.78
Bi-iliac breadth	280.14	22	11.21
Lower limb length	780.39	22	40.39
Stature (Fully)	159.29	16	6.44
Body Mass (FHD)	70.43	22	6.04
FEMALES			
Cranial index	76.44	20	4.06
Cranial module	146.63	20	2.67
Facial index	167.15	20	9.00
Nasal index	86.57	17	7.89
Relative torso height	46.93	19	1.64
Brachial index	73.24	22	2.11
Crural index	82.61	21	1.78
Relative upper limb/ torso height	144.80	20	5.57
Interlimb index	68.02	21	1.40
Upper body width	284.29	8	10.30
Bi-iliac breadth	263.41	22	12.35
Lower limb length	713.78	21	33.63
Stature (Fully)	147.78	17	4.55
Body Mass (FHD)	59.20	22	3.48

CANYON DEL MUERTO

Dimension	Mean	N	Std. Dev.
MALES			
Cranial index	76.37	9	5.85
Cranial module	148.57	11	5.12
Facial index	162.59	11	7.01
Nasal index	85.48	11	6.63
Relative torso height	48.30	6	3.00
Brachial index	79.21	18	1.83
Crural index	86.67	18	1.54
Relative upper limb/ torso height	145.91	6	8.05
Interlimb index	70.38	18	2.50
Upper body width	323.40	9	12.27
Bi-iliac breadth	265.59	16	16.35
Lower limb length	788.55	18	39.04
Stature (Fully)	157.77	6	3.27
Body Mass (FHD)	62.79	18	5.70
FEMALES			
Cranial index	77.24	6	2.95
Cranial module	141.55	9	2.27
Facial index	166.25	9	7.10
Nasal index	96.10	9	6.73
Relative torso height	48.54	5	3.99
Brachial index	78.08	10	2.05
Crural index	85.66	11	2.08
Relative upper limb/ torso height	140.33	4	11.07
Interlimb index	69.36	9	.99
Upper body width	296.49	5	9.69
Bi-iliac breadth	262.54	12	11.80
Lower limb length	726.97	11	29.89
Stature (Fully)	153.60	4	4.40
Body Mass (FHD)	51.57	12	2.89

CARTER RANCH

Dimension	Mean	N	Std. Dev.
MALES			
Cranial index			
Cranial module	151.92	8	3.93
Facial index	162.23	9	11.44
Nasal index	82.92	9	7.81
Relative torso height	48.21	5	2.26
Brachial index	78.55	9	1.69
Crural index	86.60	8	1.17
Relative upper limb/ torso height	148.37	6	8.26
Interlimb index	70.76	8	0.91
Upper body width	322.79	6	14.39
Bi-iliac breadth	270.64	7	12.56
Lower limb length	793.78	8	28.05
Stature (Fully)	160.53	5	2.09
Body Mass (FHD)	63.99	8	3.84
FEMALES			
Cranial index			
Cranial module	145.25	4	5.72
Facial index	163.77	6	7.90
Nasal index	93.35	7	9.57
Relative torso height	51.91	2	1.25
Brachial index	76.92	7	2.73
Crural index	83.77	7	1.74
Relative upper limb/ torso height	135.11	2	2.60
Interlimb index	69.21	7	1.41
Upper body width	272.35	2	7.85
Bi-iliac breadth	254.33	3	19.35
Lower limb length	691.50	7	38.56
Stature (Fully)	143.33	2	8.02
Body Mass (FHD)	47.57	7	5.00

GRASSHOPPER

Dimension	Mean	N	Std. Dev.
MALES			
Cranial index			
Cranial module	148.92	25	4.76
Facial index	175.47	24	14.23
Nasal index	91.47	15	4.95
Relative torso height	47.00	26	2.21
Brachial index	78.09	27	1.90
Crural index	86.30	27	1.71
Relative upper limb/ torso height	150.12	26	6.60
Interlimb index	70.41	27	0.98
Upper body width	323.49	15	24.07
Bi-iliac breadth	264.69	21	9.97
Lower limb length	796.30	27	40.62
Stature (Fully)	161.97	24	6.33
Body Mass (FHD)	61.49	27	5.82
FEMALES			
Cranial index	88.70	2	1.93
Cranial module	143.79	19	4.84
Facial index	172.84	17	9.09
Nasal index	93.23	14	3.33
Relative torso height	47.36	20	1.78
Brachial index	77.23	21	1.94
Crural index	85.28	21	1.65
Relative upper limb/ torso height	147.26	20	6.16
Interlimb index	69.51	21	1.59
Upper body width	292.68	15	15.72
Bi-iliac breadth	256.63	20	16.99
Lower limb length	737.80	21	33.42
Stature (Fully)	151.34	18	5.84
Body Mass (FHD)	52.52	21	4.38

KINISHBA

Dimension	Mean	N	Std. Dev.
MALES			
Cranial index			
Cranial module	144.58	4	1.57
Facial index	170.38	5	7.70
Nasal index	90.68	6	4.44
Relative torso height	43.38	2	0.32
Brachial index	78.76	12	1.75
Crural index	86.19	10	1.57
Relative upper limb/ torso height	163.16	2	2.78
Interlimb index	69.35	9	3.65
Upper body width	311.78	3	28.61
Bi-iliac breadth	269.00	2	12.73
Lower limb length	796.59	10	58.86
Stature (Fully)	167.15	1	
Body Mass (FHD)	60.14	13	7.31
FEMALES			
Cranial index	99.33	1	
Cranial module	142.17	4	5.10
Facial index	170.96	6	8.66
Nasal index	95.23	6	7.67
Relative torso height	47.27	3	1.31
Brachial index	77.50	11	2.47
Crural index	86.22	12	1.86
Relative upper limb/ torso height	146.37	3	3.47
Interlimb index	69.69	11	1.53
Upper body width	309.07	2	32.44
Bi-iliac breadth	262.17	6	20.18
Lower limb length	732.90	12	28.12
Stature (Fully)	148.47	2	1.99
Body Mass (FHD)	51.89	12	3.63

POINT OF PINES & TURKEY CREEK

Dimension	Mean	N	Std. Dev.
MALES			
Cranial index	83.73	1	
Cranial module	147.83	6	2.10
Facial index	163.92	6	7.07
Nasal index	92.72	5	6.13
Relative torso height	46.42	5	3.43
Brachial index	77.69	9	1.18
Crural index	86.17	9	1.43
Relative upper limb/ torso height	149.73	5	8.12
Interlimb index	69.83	9	1.18
Upper body width	317.80	2	14.89
Bi-iliac breadth	258.71	7	13.99
Lower limb length	790.64	9	41.13
Stature (Fully)	163.88	3	4.69
Body Mass (FHD)	60.77	9	5.72
FEMALES			
Cranial index			
Cranial module	144.27	5	3.62
Facial index	170.23	5	13.82
Nasal index	99.71	2	0.36
Relative torso height	45.08	1	
Brachial index	77.87	9	1.89
Crural index	85.86	9	1.71
Relative upper limb/ torso height	154.72	1	
Interlimb index	70.15	9	0.77
Upper body width	282.45	3	0.47
Bi-iliac breadth	253.75	8	15.65
Lower limb length	726.19	9	36.61
Stature (Fully)	142.88	1	
Body Mass (FHD)	51.78	9	4.49

SAINT FRANCIS AND BLACK RIVERS

Dimension	Mean	N	Std. Dev.
MALES			
Cranial index	77.71	1	
Cranial module	152.33	3	4.34
Facial index	166.83	3	4.39
Nasal index	85.39	3	8.35
Relative torso height			
Brachial index	77.55	11	1.95
Crural index	85.05	10	2.22
Relative upper limb/ torso height			
Interlimb index	70.21	10	0.89
Upper body width	348.22	3	11.67
Bi-iliac breadth	284.32	11	16.18
Lower limb length	843.44	10	46.17
Stature (Fully)			
Body Mass (FHD)	69.96	11	6.80
FEMALES			
Cranial index	82.53	7	2.62
Cranial module	146.53	7	3.52
Facial index	160.22	6	8.53
Nasal index	86.02	6	6.40
Relative torso height	46.83	1	
Brachial index	76.92	11	2.72
Crural index	83.93	11	2.52
Relative upper limb/ torso height	148.24	1	
Interlimb index	70.27	11	1.29
Upper body width	306.10	2	6.45
Bi-iliac breadth	266.75	8	9.77
Lower limb length	778.45	11	19.71
Stature (Fully)	161.19	1	
Body Mass (FHD)	57.13	11	3.79

BEAR CREEK & JONES SITES

Dimension	Mean	N	Std. Dev.
MALES			
Cranial index	77.65	8	3.48
Cranial module	155.50	8	2.23
Facial index	175.14	6	11.40
Nasal index	79.33	3	10.66
Relative torso height	47.34	2	1.99
Brachial index	78.17	14	2.64
Crural index	83.96	14	1.86
Relative upper limb/ torso height	143.26	1	
Interlimb index	69.04	13	1.03
Upper body width	345.49	3	16.90
Bi-iliac breadth	287.28	9	14.95
Lower limb length	840.74	14	30.29
Stature (Fully)	172.91	2	6.70
Body Mass (FHD)	69.65	14	3.79
FEMALES			
Cranial index	76.28	9	3.15
Cranial module	149.48	9	2.39
Facial index	176.97	7	9.22
Nasal index	95.95	7	9.66
Relative torso height	46.39	2	1.56
Brachial index	75.98	13	1.74
Crural index	85.00	10	1.08
Relative upper limb/ torso height	145.38	4	3.51
Interlimb index	68.79	10	2.08
Upper body width			
Bi-iliac breadth	261.58	6	8.16
Lower limb length	781.36	10	32.64
Stature (Fully)	156.52	2	1.31
Body Mass (FHD)	59.42	9	6.32

BLOSSOM (GOLDMAN)

Dimension	Mean	N	Std. Dev.
MALES			
Cranial index	76.45	18	2.42
Cranial module	157.18	18	3.61
Facial index	170.23	18	9.85
Nasal index	84.58	14	6.43
Relative torso height	48.74	10	2.43
Brachial index	79.13	18	2.79
Crural index	84.58	20	2.75
Relative upper limb/ torso height	143.84	10	6.31
Interlimb index	69.94	18	1.37
Upper body width	353.37	7	23.15
Bi-iliac breadth	280.38	17	14.06
Lower limb length	834.00	20	43.56
Stature (Fully)	169.01	10	6.26
Body Mass (FHD)	70.85	20	6.29
FEMALES			
Cranial index	75.89	15	2.49
Cranial module	152.11	15	3.68
Facial index	170.27	14	7.76
Nasal index	87.13	9	6.67
Relative torso height	50.20	6	2.54
Brachial index	76.10	16	1.70
Crural index	83.74	17	2.17
Relative upper limb/ torso height	137.93	7	9.56
Interlimb index	68.43	14	1.25
Upper body width	308.27	8	11.99
Bi-iliac breadth	269.24	17	13.13
Lower limb length	780.09	17	28.92
Stature (Fully)	160.92	6	2.82
Body Mass (FHD)	59.50	19	4.48

NORTHERN CHANNEL ISLANDS

Dimension	Mean	N	Std. Dev.
MALES			
Cranial index	70.64	2	4.62
Cranial module	149.34	2	0.94
Facial index	166.13	3	1.97
Nasal index	81.25	3	11.76
Relative torso height	43.81	1	
Brachial index	79.25	12	3.25
Crural index	84.84	12	1.65
Relative upper limb/ torso height	161.88	1	
Interlimb index	70.52	12	0.86
Upper body width	306.91	1	
Bi-iliac breadth	260.73	11	12.20
Lower limb length	788.64	12	27.39
Stature (Fully)	150.03	1	
Body Mass (FHD)	66.25	12	3.84
FEMALES			
Cranial index	77.99	6	2.95
Cranial module	147.17	6	2.97
Facial index	166.51	6	11.15
Nasal index	82.39	6	5.63
Relative torso height	46.84	3	4.14
Brachial index	76.75	14	2.64
Crural index	83.99	17	2.16
Relative upper limb/ torso height	148.67	3	12.81
Interlimb index	70.11	13	2.03
Upper body width	292.73	3	4.44
Bi-iliac breadth	256.96	14	16.77
Lower limb length	726.74	17	35.27
Stature (Fully)	144.61	3	6.30
Body Mass (FHD)	53.41	17	5.01

SAN NICHOLAS ISLAND

Dimension	Mean	N	Std. Dev.
MALES			
Cranial index	76.62	5	2.74
Cranial module	151.00	5	3.69
Facial index	171.37	5	12.99
Nasal index	82.59	5	9.01
Relative torso height	47.33	2	1.18
Brachial index	78.18	4	1.28
Crural index	85.05	4	1.34
Relative upper limb/ torso height	143.33	2	4.41
Interlimb index	68.75	3	1.66
Upper body width	331.27	3	14.98
Bi-iliac breadth	259.75	2	8.13
Lower limb length	785.69	4	14.95
Stature (Fully)	159.52	2	0.80
Body Mass (FHD)	62.31	5	5.40
FEMALES			
Cranial index	75.57	5	1.81
Cranial module	146.00	5	4.34
Facial index	159.51	4	9.14
Nasal index	75.51	4	7.80
Relative torso height	47.68	6	1.91
Brachial index	76.60	7	1.76
Crural index	85.49	8	1.35
Relative upper limb/ torso height	144.50	6	5.58
Interlimb index	69.01	7	1.56
Upper body width	297.85	5	12.96
Bi-iliac breadth	269.71	7	16.21
Lower limb length	734.88	8	21.07
Stature (Fully)	149.76	4	3.34
Body Mass (FHD)	54.38	8	3.48
Body Mass (FHD)	75.57	5	1.81

COOK

Dimension	Mean	N	Std. Dev.
MALES			
Cranial index	78.95	9	3.86
Cranial module	151.44	9	3.28
Facial index	170.68	8	10.21
Nasal index	87.82	6	3.48
Relative torso height	47.63	3	2.25
Brachial index	77.69	14	2.14
Crural index	85.23	13	2.50
Relative upper limb/ torso height	142.67	3	4.54
Interlimb index	69.05	12	1.10
Upper body width	339.86	4	8.10
Bi-iliac breadth	277.20	10	13.65
Lower limb length	835.77	13	34.84
Stature (Fully)	166.89	3	6.64
Body Mass (FHD)	68.61	15	4.66
FEMALES			
Cranial index	81.26	4	2.23
Cranial module	151.09	4	3.40
Facial index	176.18	4	5.46
Nasal index	85.32	3	1.61
Relative torso height	45.14	1	
Brachial index	77.69	3	5.94
Crural index	83.54	4	3.35
Relative upper limb/ torso height	148.15	1	
Interlimb index	68.74	3	1.86
Upper body width			
Bi-iliac breadth	268.00	1	
Lower limb length	793.00	4	20.31
Stature (Fully)	159.98	1	
Body Mass (FHD)	59.18	4	1.63

CUYAMA RANCH & TULAMNUI

Dimension	Mean	N	Std. Dev.
MALES			
Cranial index	75.54	4	1.95
Cranial module	151.92	4	1.32
Facial index	175.05	4	5.85
Nasal index	85.40	4	6.27
Relative torso height			
Brachial index	76.50	6	3.06
Crural index	84.96	4	.62
Relative upper limb/ torso height	136.72	1	
Interlimb index	70.17	4	2.67
Upper body width	331.74	1	
Bi-iliac breadth	265.17	3	5.30
Lower limb length	809.25	4	45.59
Stature (Fully)			
Body Mass (FHD)	63.69	6	5.97
FEMALES			
Cranial index	78.42	4	2.25
Cranial module	146.33	4	2.80
Facial index	182.74	5	13.20
Nasal index	86.38	6	6.78
Relative torso height	48.99	2	2.68
Brachial index	76.08	5	2.42
Crural index	84.18	6	1.70
Relative upper limb/ torso height	145.24	2	10.26
Interlimb index	70.55	5	1.41
Upper body width	276.32	2	50.42
Bi-iliac breadth	250.75	6	25.74
Lower limb length	713.32	6	55.52
Stature (Fully)	144.99	2	12.72
Body Mass (FHD)	55.35	6	5.76

ELLIS LANDING

Dimension	Mean	N	Std. Dev.
MALES			
Cranial index	77.87	2	5.02
Cranial module	154.67	2	3.30
Facial index	179.79	2	2.26
Nasal index	93.05	2	5.40
Relative torso height	51.11	1	
Brachial index	78.73	12	2.01
Crural index	83.82	9	1.39
Relative upper limb/ torso height	141.17	1	
Interlimb index	69.60	9	1.53
Upper body width	328.90	3	16.45
Bi-iliac breadth	277.13	8	14.08
Lower limb length	808.62	9	35.58
Stature (Fully)	162.72	1	
Body Mass (FHD)	71.11	11	6.47
FEMALES			
Cranial index	77.47	1	
Cranial module	151.67	1	
Facial index	179.37	2	18.84
Nasal index	93.75	1	
Relative torso height	40.44	1	
Brachial index	78.03	5	3.31
Crural index	84.34	6	1.53
Relative upper limb/ torso height	172.55	1	
Interlimb index	69.14	4	1.75
Upper body width	326.67	1	
Bi-iliac breadth	272.50	4	19.71
Lower limb length	776.67	6	30.11
Stature (Fully)			
Body Mass (FHD)	56.93	7	3.30

SACRAMENTO RIVER VALLEY

Dimension	Mean	N	Std. Dev.
MALES			
Cranial index	80.07	7	3.20
Cranial module	154.05	7	3.73
Facial index	168.98	7	9.31
Nasal index	80.55	7	8.12
Relative torso height	45.79	5	3.29
Brachial index	78.58	7	1.12
Crural index	85.50	8	1.08
Relative upper limb/ torso height	152.44	5	10.64
Interlimb index	69.46	7	0.71
Upper body width	325.12	4	35.06
Bi-iliac breadth	269.13	8	19.29
Lower limb length	816.19	8	68.24
Stature (Fully)	167.01	4	11.40
Body Mass (FHD)	66.99	8	8.58
FEMALES			
Cranial index	82.04	9	2.57
Cranial module	147.82	9	3.99
Facial index	174.08	9	9.31
Nasal index	85.94	9	5.76
Relative torso height	47.73	4	2.20
Brachial index	76.32	8	1.83
Crural index	85.02	8	1.60
Relative upper limb/ torso height	145.96	4	10.68
Interlimb index	68.87	7	2.58
Upper body width	296.57	5	17.87
Bi-iliac breadth	263.07	7	13.60
Lower limb length	759.53	8	31.65
Stature (Fully)	155.85	4	4.18
Body Mass (FHD)	57.61	8	3.04

KARLO

Dimension	Mean	N	Std. Dev.
MALES			
Cranial index	70.98	1	
Cranial module	153.67	1	
Facial index	175.99	1	
Nasal index	90.38	1	
Relative torso height	46.82	1	
Brachial index	78.77	2	0.06
Crural index	83.00	2	0.75
Relative upper limb/ torso height	148.87	1	
Interlimb index	69.38	2	0.46
Upper body width	334.36	1	
Bi-iliac breadth	278.00	1	
Lower limb length	810.50	2	29.35
Stature (Fully)	161.02	1	
Body Mass (FHD)	66.77	2	0.42
FEMALES			
Cranial index	72.82	4	2.55
Cranial module	153.92	4	10.37
Facial index	175.45	5	6.74
Nasal index	91.44	4	9.89
Relative torso height	51.14	2	0.49
Brachial index	74.15	6	3.47
Crural index	84.07	7	2.56
Relative upper limb/ torso height	133.27	2	5.31
Interlimb index	67.76	6	2.65
Upper body width	299.61	2	6.51
Bi-iliac breadth	277.75	4	11.15
Lower limb length	747.54	7	65.62
Stature (Fully)	156.35	2	2.43
Body Mass (FHD)	59.92	7	7.36

LA JOLLA

Dimension	Mean	N	Std. Dev.
MALES			
Cranial index	76.07	10	2.54
Cranial module	158.73	10	5.74
Facial index	175.56	6	11.08
Nasal index	88.00	4	9.15
Relative torso height			
Brachial index	79.39	6	4.34
Crural index	84.02	6	1.65
Relative upper limb/ torso height			
Interlimb index	68.14	3	1.79
Upper body width			
Bi-iliac breadth	285.50	2	0.71
Lower limb length	780.45	5	34.17
Stature (Fully)			
Body Mass (FHD)	64.60	7	5.67
FEMALES			
Cranial index	75.02	12	4.39
Cranial module	148.27	11	5.95
Facial index	167.36	10	6.06
Nasal index	89.96	10	6.58
Relative torso height	49.49	1	
Brachial index	78.13	4	2.27
Crural index	84.78	5	1.13
Relative upper limb/ torso height	139.41	1	
Interlimb index	69.51	2	0.73
Upper body width	289.93	1	
Bi-iliac breadth	272.25	4	9.95
Lower limb length	765.64	4	35.29
Stature (Fully)	151.99	1	
Body Mass (FHD)	56.53	7	4.84

MUSTANG MOUND

Dimension	Mean	N	Std. Dev.
MALES			
Cranial index	78.02	6	2.91
Cranial module	153.67	6	5.39
Facial index	170.23	6	7.97
Nasal index	84.55	6	7.10
Relative torso height			
Brachial index	78.22	9	2.32
Crural index	85.54	10	1.76
Relative upper limb/ torso height			
Interlimb index	69.46	9	1.39
Upper body width	336.77	1	
Bi-iliac breadth	276.94	9	11.92
Lower limb length	818.88	10	36.35
Stature (Fully)			
Body Mass (FHD)	70.56	10	2.60
FEMALES			
Cranial index	78.17	7	1.85
Cranial module	149.62	7	3.95
Facial index	171.66	7	8.75
Nasal index	89.07	7	8.31
Relative torso height	47.36	1	
Brachial index	78.11	5	1.42
Crural index	84.67	7	2.40
Relative upper limb/ torso height	147.37	1	
Interlimb index	69.71	4	0.33
Upper body width	296.04	1	
Bi-iliac breadth	271.25	6	9.78
Lower limb length	761.39	7	15.97
Stature (Fully)	150.42	1	
Body Mass (FHD)	57.82	7	4.04

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Dimension	Mean	N	Std. Dev.
MALES			
Cranial index	77.88	11	3.69
Cranial module	154.24	11	3.41
Facial index	171.21	10	7.25
Nasal index	84.23	7	7.64
Relative torso height	47.59	4	2.10
Brachial index	78.08	13	1.68
Crural index	85.03	12	1.78
Relative upper limb/ torso height	148.58	4	7.45
Interlimb index	70.42	10	1.21
Upper body width	341.38	4	25.38
Bi-iliac breadth	280.17	9	14.59
Lower limb length	810.69	12	29.46
Stature (Fully)	162.01	4	5.37
Body Mass (FHD)	67.32	14	5.78
FEMALES			
Cranial index	78.04	11	2.44
Cranial module	150.58	11	3.57
Facial index	172.00	11	7.82
Nasal index	88.31	11	7.75
Relative torso height	50.00	2	1.66
Brachial index	77.27	12	2.26
Crural index	84.24	11	2.02
Relative upper limb/ torso height	136.52	2	0.41
Interlimb index	68.77	11	1.73
Upper body width	302.83	2	7.30
Bi-iliac breadth	261.40	10	9.67
Lower limb length	756.07	11	33.69
Stature (Fully)	159.88	2	3.63
Body Mass (FHD)	55.31	12	3.74

POINT SAL

Dimension	Mean	N	Std. Dev.
MALES			
Cranial index	76.14	13	3.56
Cranial module	153.74	14	2.80
Facial index	169.78	12	8.02
Nasal index	83.89	7	10.53
Relative torso height			
Brachial index	77.61	9	1.48
Crural index	86.31	11	2.66
Relative upper limb/ torso height			
Interlimb index	71.50	8	2.39
Upper body width	323.56	1	
Bi-iliac breadth	262.67	6	10.76
Lower limb length	787.97	11	32.41
Stature (Fully)			
Body Mass (FHD)	63.36	14	3.40
FEMALES			
Cranial index	79.75	7	2.21
Cranial module	148.33	7	2.36
Facial index	174.40	6	10.31
Nasal index	83.18	6	4.53
Relative torso height			
Brachial index	77.85	3	0.32
Crural index	84.88	4	1.43
Relative upper limb/ torso height			
Interlimb index	70.18	2	1.15
Upper body width			
Bi-iliac breadth	251.88	4	20.14
Lower limb length	702.41	4	31.90
Stature (Fully)			
Body Mass (FHD)	54.52	7	5.52

RYAN MOUND

Dimension	Mean	N	Std. Dev.
MALES			
Cranial index	76.28	35	2.73
Cranial module	150.95	35	3.46
Facial index	170.40	35	10.20
Nasal index	83.99	32	9.03
Relative torso height	47.53	24	2.00
Brachial index	77.94	40	1.79
Crural index	84.50	40	1.62
Relative upper limb/ torso height	147.66	24	6.12
Interlimb index	70.20	40	1.39
Upper body width	320.83	25	16.55
Bi-iliac breadth	269.47	37	15.22
Lower limb length	793.01	40	29.76
Stature (Fully)	161.74	22	4.07
Body Mass (FHD)	64.97	40	4.81
FEMALES			
Cranial index	77.80	34	2.90
Cranial module	145.81	34	3.17
Facial index	170.83	34	9.80
Nasal index	90.01	33	7.07
Relative torso height	49.12	21	2.40
Brachial index	75.80	38	2.72
Crural index	84.02	38	1.58
Relative upper limb/ torso height	141.21	21	7.37
Interlimb index	69.36	37	1.44
Upper body width	290.43	28	12.44
Bi-iliac breadth	266.19	36	11.41
Lower limb length	738.71	38	26.44
Stature (Fully)	152.92	20	2.99
Body Mass (FHD)	54.44	38	3.07

WESTERN BERKELEY

Dimension	Mean	N	Std. Dev.
MALES			
Cranial index	74.28	5	2.85
Cranial module	158.67	4	2.68
Facial index	169.23	4	7.23
Nasal index	79.33	1	
Relative torso height	46.86	1	
Brachial index	77.79	7	2.80
Crural index	84.50	7	2.59
Relative upper limb/ torso height	144.25	1	
Interlimb index	68.98	7	1.66
Upper body width	330.55	2	5.62
Bi-iliac breadth	281.90	5	4.51
Lower limb length	825.88	7	28.81
Stature (Fully)	164.72	1	
Body Mass (FHD)	68.98	7	4.64
FEMALES			
Cranial index	76.85	3	1.62
Cranial module	152.78	3	1.35
Facial index	170.32	3	12.97
Nasal index	79.62	2	13.15
Relative torso height			
Brachial index	75.93	4	2.88
Crural index	83.72	2	.33
Relative upper limb/ torso height	153.49	1	
Interlimb index	68.09	2	1.30
Upper body width			
Bi-iliac breadth	268.00	3	5.29
Lower limb length	787.00	2	57.63
Stature (Fully)			
Body Mass (FHD)	59.86	4	6.31

YERBA BUENA & CENTRAL SAN FRANCISCO BAY

Dimension	Mean	N	Std. Dev.
MALES			
Cranial index	74.05	7	3.43
Cranial module	153.81	7	2.89
Facial index	174.38	7	11.30
Nasal index	78.94	4	10.20
Relative torso height	47.14	5	1.76
Brachial index	79.60	8	1.75
Crural index	84.41	8	1.53
Relative upper limb/ torso height	146.31	5	7.21
Interlimb index	68.84	8	1.30
Upper body width	315.97	2	9.83
Bi-iliac breadth	277.83	6	16.48
Lower limb length	814.72	8	39.28
Stature (Fully)	161.54	4	1.48
Body Mass (FHD)	67.00	8	6.34
FEMALES			
Cranial index	73.20	2	3.15
Cranial module	146.83	2	2.12
Facial index	170.03	2	5.76
Nasal index	87.91	2	5.93
Relative torso height	45.13	1	
Brachial index	78.32	2	0.50
Crural index	85.76	2	0.25
Relative upper limb/ torso height	153.66	1	
Interlimb index	69.36	2	0.03
Upper body width	297.35	2	1.20
Bi-iliac breadth	273.00	2	1.41
Lower limb length	778.39	2	14.30
Stature (Fully)	157.19	1	
Body Mass (FHD)	63.27	2	1.25

YUMA III

Dimension	Mean	N	Std. Dev.
MALES			
Cranial index	75.75	4	2.06
Cranial module	148.09	4	4.87
Facial index	175.90	4	7.60
Nasal index	90.85	3	5.24
Relative torso height			
Brachial index	81.04	2	5.05
Crural index	86.55	3	1.91
Relative upper limb/ torso height			
Interlimb index	70.77	2	0.44
Upper body width	325.62	1	
Bi-iliac breadth	276.50	2	26.16
Lower limb length	810.58	3	44.46
Stature (Fully)			
Body Mass (FHD)	69.64	3	7.55
FEMALES			
Cranial index	79.64	3	7.28
Cranial module	145.50	4	4.04
Facial index	177.91	4	6.92
Nasal index	92.56	3	1.42
Relative torso height			
Brachial index	78.44	3	1.19
Crural index	86.27	2	1.54
Relative upper limb/ torso height			
Interlimb index	70.65	2	0.02
Upper body width	295.40	2	10.43
Bi-iliac breadth	273.67	3	8.50
Lower limb length	725.25	2	13.44
Stature (Fully)			
Body Mass (FHD)	54.13	2	4.19

ACKMEN / YELLOW JACKET

Dimension	Mean	N	Std. Dev.
MALES			
Cranial index			
Cranial module	153.60	5	3.61
Facial index	175.06	4	10.88
Nasal index	97.12	5	9.05
Relative torso height	42.87	1	
Brachial index	77.65	3	1.93
Crural index	84.76	2	3.47
Relative upper limb/ torso height	162.44	1	
Interlimb index	69.51	2	0.18
Upper body width			
Bi-iliac breadth	279.00	2	1.41
Lower limb length	816.25	2	37.83
Stature (Fully)	166.65	1	
Body Mass (FHD)	64.85	2	5.28
FEMALES			
Cranial index			
Cranial module	143.47	5	2.33
Facial index	172.20	5	5.84
Nasal index	94.25	6	4.67
Relative torso height	45.56	1	
Brachial index	77.42	6	1.34
Crural index	83.08	4	0.77
Relative upper limb/ torso height	154.61	1	
Interlimb index	70.67	4	0.76
Upper body width	286.08	2	24.70
Bi-iliac breadth	257.75	4	9.11
Lower limb length	727.38	4	31.20
Stature (Fully)			
Body Mass (FHD)	50.11	6	2.78

BAYSHORE MOUNDS

Dimension	Mean	N	Std. Dev.
MALES			
Cranial index	81.65	8	3.18
Cranial module	151.17	8	2.89
Facial index	169.28	9	8.21
Nasal index	88.47	7	5.42
Relative torso height			
Brachial index	76.72	5	1.90
Crural index	84.90	3	1.16
Relative upper limb/ torso height			
Interlimb index	70.15	3	2.58
Upper body width			
Bi-iliac breadth	272.00	1	
Lower limb length	762.00	3	36.07
Stature (Fully)			
Body Mass (FHD)	62.63	5	5.19
FEMALES			
Cranial index	80.87	11	2.13
Cranial module	148.33	11	4.17
Facial index	171.77	10	5.10
Nasal index	90.65	8	3.32
Relative torso height	50.65	1	
Brachial index	74.96	6	1.57
Crural index	84.52	4	1.52
Relative upper limb/ torso height	136.69	1	
Interlimb index	69.79	4	3.00
Upper body width	303.15	2	2.13
Bi-iliac breadth	265.33	3	16.29
Lower limb length	758.08	4	40.52
Stature (Fully)	155.45	1	
Body Mass (FHD)	56.01	6	1.35

PALMER

Dimension	Mean	N	Std. Dev.
MALES			
Cranial index	78.59	13	3.33
Cranial module	155.00	13	3.62
Facial index	173.91	11	12.19
Nasal index	89.84	9	5.88
Relative torso height	46.22	4	1.77
Brachial index	75.98	15	2.91
Crural index	84.39	11	2.56
Relative upper limb/ torso height	150.76	4	7.66
Interlimb index	68.85	9	1.68
Upper body width	316.79	3	10.32
Bi-iliac breadth	266.60	5	15.58
Lower limb length	812.02	11	28.55
Stature (Fully)	161.87	4	4.84
Body Mass (FHD)	65.42	17	3.88
FEMALES			
Cranial index			
Cranial module	79.03	15	2.88
Facial index	148.60	15	3.35
Nasal index	171.80	15	9.69
Relative torso height	92.17	13	3.48
Brachial index	46.62	5	0.93
Crural index	76.04	15	1.97
Relative upper limb/ torso height	84.75	13	1.27
Interlimb index	146.52	5	4.99
Upper body width	68.57	11	1.40
Bi-iliac breadth	299.65	2	4.22
Lower limb length	273.00	9	14.33
Stature (Fully)	767.15	13	24.11
Body Mass (FHD)	156.34	5	2.50

TICK ISLAND

Dimension	Mean	N	Std. Dev.
MALES			
Cranial index			
Cranial module			
Facial index			
Nasal index			
Relative torso height	47.30	1	
Brachial index	77.86	3	2.80
Crural index	85.42	2	0.57
Relative upper limb/ torso height	153.97	1	
Interlimb index	71.32	2	2.12
Upper body width			
Bi-iliac breadth	256.00	2	5.66
Lower limb length	801.25	2	45.61
Stature (Fully)			
Body Mass (FHD)	65.67	3	3.30
FEMALES			
Cranial index			
Cranial module			
Facial index			
Nasal index	89.69	1	
Relative torso height	52.43	1	
Brachial index	74.32	2	0.62
Crural index	83.73	2	0.70
Relative upper limb/ torso height	133.20	1	
Interlimb index	68.74	2	1.55
Upper body width	315.21	1	
Bi-iliac breadth	264.00	1	
Lower limb length	735.92	2	13.54
Stature (Fully)			
Body Mass (FHD)	54.45	2	0.65

WINDOVER

Dimension	Mean	N	Std. Dev.
MALES			
Cranial index	73.94	37	3.26
Cranial module	152.00	36	3.01
Facial index	173.11	27	10.11
Nasal index	89.54	27	8.28
Relative torso height	44.74	13	1.75
Brachial index	79.47	32	1.69
Crural index	85.50	28	1.91
Relative upper limb/ torso height	153.37	14	6.60
Interlimb index	68.73	23	1.14
Upper body width	327.12	7	14.21
Bi-iliac breadth	265.42	19	10.93
Lower limb length	819.92	28	33.99
Stature (Fully)	166.32	11	4.77
Body Mass (FHD)	65.00	38	5.40
FEMALES			
Cranial index	74.45	30	2.38
Cranial module	146.01	29	4.48
Facial index	175.87	22	9.58
Nasal index	89.91	22	6.06
Relative torso height	45.29	7	2.56
Brachial index	77.59	21	2.77
Crural index	85.23	18	2.52
Relative upper limb/ torso height	150.40	7	10.54
Interlimb index	68.55	17	1.48
Upper body width	289.77	6	11.26
Bi-iliac breadth	250.94	8	17.77
Lower limb length	760.59	18	35.38
Stature (Fully)	154.77	6	3.00
Body Mass (FHD)	54.49	21	4.62

IRENE MOUND

Dimension	Mean	N	Std. Dev.
MALES			
Cranial index	81.28	10	5.67
Cranial module	153.13	10	3.84
Facial index	168.84	10	10.00
Nasal index	84.46	12	8.55
Relative torso height	46.14	4	1.74
Brachial index	78.16	12	2.46
Crural index	85.55	10	2.49
Relative upper limb/ torso height	154.30	4	6.43
Interlimb index	70.09	10	2.23
Upper body width	327.55	5	13.76
Bi-iliac breadth	268.58	6	17.42
Lower limb length	817.30	10	41.07
Stature (Fully)	172.15	3	8.63
Body Mass (FHD)	64.29	12	8.42
FEMALES			
Cranial index	83.71	17	5.85
Cranial module	145.73	17	2.82
Facial index	171.51	14	7.17
Nasal index	86.88	17	5.11
Relative torso height	47.70	7	3.06
Brachial index	76.16	17	3.04
Crural index	84.22	18	2.10
Relative upper limb/ torso height	145.64	6	11.63
Interlimb index	69.37	16	2.30
Upper body width	280.13	5	14.31
Bi-iliac breadth	253.12	13	9.56
Lower limb length	763.33	18	31.23
Stature (Fully)	155.55	7	6.67
Body Mass (FHD)	53.15	19	5.73

ALBANY MOUNDS

Dimension	Mean	N	Std. Dev.
MALES			
Cranial index	80.41	5	6.18
Cranial module	151.20	5	2.00
Facial index	168.33	6	12.90
Nasal index	83.35	6	7.11
Relative torso height	48.77	1	
Brachial index	74.80	8	2.41
Crural index	83.91	10	1.43
Relative upper limb/ torso height			
Interlimb index	69.94	8	2.04
Upper body width	348.84	2	15.22
Bi-iliac breadth	255.33	3	10.79
Lower limb length	821.88	10	31.77
Stature (Fully)			
Body Mass (FHD)	66.59	10	6.39
FEMALES			
Cranial index	79.39	6	5.47
Cranial module	148.39	6	2.86
Facial index	166.24	6	7.75
Nasal index	90.50	5	6.92
Relative torso height	47.41	1	
Brachial index	73.48	4	4.90
Crural index	84.29	5	.49
Relative upper limb/ torso height	140.79	1	
Interlimb index	68.62	3	1.93
Upper body width			
Bi-iliac breadth	272.00	3	6.93
Lower limb length	763.20	5	26.21
Stature (Fully)			
Body Mass (FHD)	56.55	7	4.43

DICKSON

Dimension	Mean	N	Std. Dev.
MALES			
Cranial index	79.19	18	4.12
Cranial module	153.67	25	4.13
Facial index	167.27	21	10.58
Nasal index	89.84	17	4.70
Relative torso height	46.61	22	2.09
Brachial index	78.05	24	2.07
Crural index	84.43	25	2.34
Relative upper limb/ torso height	150.06	21	6.15
Interlimb index	69.89	24	1.38
Upper body width	336.50	14	18.53
Bi-iliac breadth	283.00	21	14.82
Lower limb length	834.30	25	37.82
Stature (Fully)	168.98	21	4.75
Body Mass (FHD)	67.87	25	4.71
FEMALES			
Cranial index	80.99	15	4.06
Cranial module	149.75	20	2.99
Facial index	170.25	16	9.09
Nasal index	90.45	12	5.44
Relative torso height	48.69	20	1.79
Brachial index	76.56	27	2.20
Crural index	84.33	25	1.89
Relative upper limb/ torso height	144.63	20	5.96
Interlimb index	70.42	26	1.74
Upper body width	302.50	17	20.23
Bi-iliac breadth	268.20	23	12.52
Lower limb length	769.96	26	35.29
Stature (Fully)	158.79	16	5.86
Body Mass (FHD)	57.76	27	4.73

ELIZABETH MIDDLE WOODLAND

Dimension	Mean	N	Std. Dev.
MALES			
Cranial index	77.21	27	3.29
Cranial module	152.09	26	3.67
Facial index	164.79	25	12.94
Nasal index	87.12	28	10.63
Relative torso height	46.51	16	1.80
Brachial index	78.42	44	2.22
Crural index	85.49	43	2.44
Relative upper limb/ torso height	150.80	18	6.42
Interlimb index	70.29	42	1.73
Upper body width	341.05	7	19.51
Bi-iliac breadth	274.24	38	15.22
Lower limb length	819.81	43	43.60
Stature (Fully)	165.60	9	4.74
Body Mass (FHD)	65.30	45	5.65
FEMALES			
Cranial index	77.48	17	2.57
Cranial module	146.65	19	3.31
Facial index	164.66	19	10.22
Nasal index	90.71	19	8.62
Relative torso height	47.06	8	2.00
Brachial index	76.57	21	2.32
Crural index	84.74	21	2.07
Relative upper limb/ torso height	149.63	8	5.95
Interlimb index	70.14	20	1.94
Upper body width	316.74	7	20.40
Bi-iliac breadth	266.11	22	11.55
Lower limb length	769.01	21	41.75
Stature (Fully)	159.48	8	7.12
Body Mass (FHD)	56.02	22	6.45

KUHLMAN

Dimension	Mean	N	Std. Dev.
MALES			
Cranial index	74.99	7	2.38
Cranial module	151.52	7	1.52
Facial index	158.44	7	9.93
Nasal index	93.95	8	4.39
Relative torso height	47.62	5	1.64
Brachial index	77.54	8	2.45
Crural index	85.77	8	1.52
Relative upper limb/ torso height	147.31	5	3.99
Interlimb index	70.07	8	1.64
Upper body width	324.78	5	22.58
Bi-iliac breadth	270.25	4	8.87
Lower limb length	806.53	8	26.45
Stature (Fully)	163.23	5	3.11
Body Mass (FHD)	63.27	8	3.58
FEMALES			
Cranial index	76.66	6	1.91
Cranial module	146.33	6	1.52
Facial index	161.03	6	6.52
Nasal index	92.08	6	4.41
Relative torso height	46.42	4	1.91
Brachial index	75.80	6	1.89
Crural index	84.47	6	3.47
Relative upper limb/ torso height	152.12	4	6.74
Interlimb index	70.08	6	1.13
Upper body width	296.10	5	10.71
Bi-iliac breadth	256.17	3	10.07
Lower limb length	767.26	6	22.76
Stature (Fully)	154.67	4	2.73
Body Mass (FHD)	56.29	6	6.63

MODOC ROCK SHELTER

Dimension	Mean	N	Std. Dev.
MALES			
Cranial index	76.12	3	2.06
Cranial module	154.78	3	1.07
Facial index	181.25	4	19.26
Nasal index	88.44	5	6.61
Relative torso height	45.49	4	1.10
Brachial index	77.55	7	2.28
Crural index	86.99	6	2.59
Relative upper limb/ torso height	153.73	4	3.51
Interlimb index	69.02	6	1.88
Upper body width	336.05	5	15.43
Bi-iliac breadth	273.67	3	21.08
Lower limb length	837.54	6	61.22
Stature (Fully)	171.15	3	5.02
Body Mass (FHD)	66.25	6	6.95
FEMALES			
Cranial index	78.53	7	4.73
Cranial module	149.67	6	3.84
Facial index	180.18	3	9.22
Nasal index	72.83	3	6.94
Relative torso height	46.19	3	1.89
Brachial index	78.95	7	2.55
Crural index	85.24	6	2.68
Relative upper limb/ torso height	151.74	4	6.00
Interlimb index	71.10	5	0.97
Upper body width	318.82	2	25.29
Bi-iliac breadth	260.00	2	5.66
Lower limb length	761.87	6	45.14
Stature (Fully)	158.24	1	
Body Mass (FHD)	56.50	9	7.74

INDIAN KNOLL

Dimension	Mean	N	Std. Dev.
MALES			
Cranial index	76.67	27	2.89
Cranial module	150.10	27	3.90
Facial index	173.13	28	9.53
Nasal index	84.66	24	7.23
Relative torso height	45.99	23	2.12
Brachial index	77.14	31	2.44
Crural index	84.51	31	1.88
Relative upper limb/ torso height	153.73	23	6.58
Interlimb index	70.87	31	1.76
Upper body width	312.73	23	21.24
Bi-iliac breadth	258.68	30	10.80
Lower limb length	798.09	31	38.05
Stature (Fully)	161.35	20	5.36
Body Mass (FHD)	60.32	31	4.80
FEMALES			
Cranial index	76.63	28	2.83
Cranial module	144.24	28	3.48
Facial index	169.88	29	10.13
Nasal index	88.09	26	8.33
Relative torso height	47.42	21	2.11
Brachial index	75.00	30	2.47
Crural index	83.93	29	1.87
Relative upper limb/ torso height	148.76	22	5.98
Interlimb index	70.59	29	1.36
Upper body width	285.33	22	10.65
Bi-iliac breadth	249.84	29	11.67
Lower limb length	733.21	29	33.83
Stature (Fully)	150.22	21	5.57
Body Mass (FHD)	50.28	30	4.24

WARD PLACE

Dimension	Mean	N	Std. Dev.
MALES			
Cranial index	81.61	3	2.00
Cranial module	152.17	8	3.62
Facial index	173.25	5	11.37
Nasal index	97.66	5	11.35
Relative torso height	46.70	4	1.60
Brachial index	78.40	10	1.90
Crural index	83.73	11	2.81
Relative upper limb/ torso height	151.98	4	3.93
Interlimb index	70.30	10	1.35
Upper body width			
Bi-iliac breadth	273.69	8	18.61
Lower limb length	817.39	11	30.59
Stature (Fully)	166.73	2	3.88
Body Mass (FHD)	68.73	11	4.19
FEMALES			
Cranial index	81.40	4	1.66
Cranial module	147.45	11	4.63
Facial index	175.26	11	11.22
Nasal index	92.34	11	9.61
Relative torso height	46.19	1	
Brachial index	76.30	10	1.73
Crural index	84.41	8	1.21
Relative upper limb/ torso height	146.59	2	3.85
Interlimb index	69.39	8	1.86
Upper body width	329.02	3	21.44
Bi-iliac breadth	266.69	8	9.92
Lower limb length	775.06	8	41.80
Stature (Fully)			
Body Mass (FHD)	56.73	9	6.43

MAINE

Dimension	Mean	N	Std. Dev.
MALES			
Cranial index	73.57	7	3.42
Cranial module	154.05	7	7.38
Facial index	163.98	5	4.87
Nasal index	85.53	4	8.62
Relative torso height	48.20	2	3.91
Brachial index	76.84	6	3.78
Crural index	83.84	6	1.83
Relative upper limb/ torso height	146.20	2	9.09
Interlimb index	70.05	6	1.18
Upper body width	335.84	1	
Bi-iliac breadth	263.13	4	13.19
Lower limb length	808.50	6	46.59
Stature (Fully)	165.99	2	7.32
Body Mass (FHD)	63.67	6	5.22
FEMALES			
Cranial index	75.54	5	5.21
Cranial module	150.66	5	4.03
Facial index	163.33	3	3.44
Nasal index	88.11	3	2.44
Relative torso height	43.84	1	
Brachial index	77.71	2	3.57
Crural index	85.01	2	1.60
Relative upper limb/ torso height	157.28	1	
Interlimb index	70.89	2	2.74
Upper body width	288.37	1	
Bi-iliac breadth	257.50	2	4.95
Lower limb length	756.88	2	42.25
Stature (Fully)	157.48	1	
Body Mass (FHD)	56.31	2	7.03

CAPE COD BAY

Dimension	Mean	N	Std. Dev.
MALES			
Cranial index	74.47	10	3.00
Cranial module	152.70	10	5.38
Facial index	170.91	9	7.28
Nasal index	86.59	9	7.93
Relative torso height	44.66	7	1.69
Brachial index	79.31	10	2.11
Crural index	84.58	12	1.80
Relative upper limb/ torso height	156.90	6	5.80
Interlimb index	70.67	10	1.89
Upper body width	340.29	4	25.82
Bi-iliac breadth	263.67	9	8.47
Lower limb length	832.79	12	48.24
Stature (Fully)	167.40	6	6.32
Body Mass (FHD)	64.56	12	5.15
FEMALES			
Cranial index	75.66	9	4.30
Cranial module	148.70	9	4.29
Facial index	170.49	8	16.25
Nasal index	94.17	9	6.50
Relative torso height	42.72	3	3.42
Brachial index	77.05	13	2.54
Crural index	83.64	12	1.80
Relative upper limb/ torso height	161.76	3	13.68
Interlimb index	68.95	12	1.08
Upper body width	292.26	2	4.62
Bi-iliac breadth	258.05	10	14.13
Lower limb length	789.15	12	28.44
Stature (Fully)	156.68	3	1.93
Body Mass (FHD)	57.26	13	4.65

WINNEMUCCA

Dimension	Mean	N	Std. Dev.
MALES			
Cranial index	76.83	4	6.53
Cranial module	149.25	4	4.30
Facial index	165.78	4	11.22
Nasal index	83.91	4	6.22
Relative torso height			
Brachial index	74.26	1	
Crural index	83.71	2	2.30
Relative upper limb/ torso height			
Interlimb index	69.73	1	
Upper body width			
Bi-iliac breadth			
Lower limb length	808.63	2	35.58
Stature (Fully)			
Body Mass (FHD)	72.50	2	11.26
FEMALES			
Cranial index	75.59	3	2.24
Cranial module	149.78	3	3.95
Facial index	167.44	3	1.29
Nasal index	87.67	3	9.18
Relative torso height	51.04	1	
Brachial index	78.02	3	3.66
Crural index	82.21	1	
Relative upper limb/ torso height	135.34	1	
Interlimb index	69.08	1	
Upper body width	302.36	1	
Bi-iliac breadth	262.00	1	
Lower limb length	728.50	1	
Stature (Fully)	156.09	1	
Body Mass (FHD)	64.03	2	2.42

MONTAGUE

Dimension	Mean	N	Std. Dev.
MALES			
Cranial index	77.81	7	6.34
Cranial module	153.52	7	3.08
Facial index	171.35	7	7.09
Nasal index	82.05	7	7.43
Relative torso height	45.79	6	1.96
Brachial index	78.77	9	2.34
Crural index	85.96	9	2.50
Relative upper limb/ torso height	152.64	6	5.81
Interlimb index	69.71	8	1.12
Upper body width	333.04	7	13.19
Bi-iliac breadth	262.19	8	12.41
Lower limb length	835.70	9	21.64
Stature (Fully)	167.36	5	3.21
Body Mass (FHD)	67.37	9	4.62
FEMALES			
Cranial index	82.08	11	6.37
Cranial module	145.46	11	3.59
Facial index	172.25	11	15.68
Nasal index	90.42	11	5.86
Relative torso height	47.11	10	2.08
Brachial index	77.78	10	1.33
Crural index	84.65	11	1.65
Relative upper limb/ torso height	149.55	9	6.20
Interlimb index	69.83	10	1.01
Upper body width	303.04	8	17.42
Bi-iliac breadth	257.73	11	12.53
Lower limb length	774.48	11	30.21
Stature (Fully)	157.26	10	4.35
Body Mass (FHD)	56.78	11	5.06

CHACO CANYON

Dimension	Mean	N	Std. Dev.
MALES			
Cranial index	85.63	1	
Cranial module	151.73	5	4.83
Facial index	165.88	5	14.38
Nasal index	87.33	5	7.67
Relative torso height	46.68	4	1.93
Brachial index	77.65	6	2.37
Crural index	85.07	7	0.86
Relative upper limb/ torso height	148.72	3	10.12
Interlimb index	69.65	5	1.19
Upper body width	352.98	2	3.44
Bi-iliac breadth	272.50	6	13.22
Lower limb length	807.77	7	48.48
Stature (Fully)	169.28	4	3.93
Body Mass (FHD)	61.77	8	7.21
FEMALES			
Cranial index	87.26	4	2.37
Cranial module	149.83	8	7.23
Facial index	161.97	8	9.02
Nasal index	89.54	7	8.23
Relative torso height	47.61	13	2.54
Brachial index	77.84	16	1.89
Crural index	84.13	16	1.89
Relative upper limb/ torso height	144.82	13	7.66
Interlimb index	68.48	15	1.68
Upper body width	297.54	11	17.50
Bi-iliac breadth	260.34	16	15.31
Lower limb length	749.24	16	36.68
Stature (Fully)	157.21	6	6.13
Body Mass (FHD)	49.28	17	4.37

CHAMISAL

Dimension	Mean	N	Std. Dev.
MALES			
Cranial index			
Cranial module	149.17	4	2.19
Facial index	170.89	6	10.73
Nasal index	89.43	5	4.48
Relative torso height	49.55	3	3.33
Brachial index	78.05	7	2.73
Crural index	84.84	6	0.81
Relative upper limb/ torso height	147.88	4	10.78
Interlimb index	71.57	6	2.11
Upper body width	321.04	5	20.06
Bi-iliac breadth	261.67	6	14.53
Lower limb length	761.13	6	49.68
Stature (Fully)	157.97	3	8.01
Body Mass (FHD)	61.38	7	5.29
FEMALES			
Cranial index	71.82	1	
Cranial module	148.46	5	5.94
Facial index	170.71	4	9.05
Nasal index	98.37	4	2.27
Relative torso height	47.86	4	2.76
Brachial index	76.16	4	1.29
Crural index	83.30	5	.86
Relative upper limb/ torso height	146.55	4	8.07
Interlimb index	69.99	4	1.97
Upper body width	284.75	4	20.67
Bi-iliac breadth	253.13	4	13.43
Lower limb length	704.44	5	57.71
Stature (Fully)	144.94	3	8.56
Body Mass (FHD)	47.90	5	3.93

GALLINA SPRINGS

Dimension	Mean	N	Std. Dev.
MALES			
Cranial index	78.74	1	
Cranial module	149.53	5	4.98
Facial index	169.59	5	12.36
Nasal index	97.03	3	4.27
Relative torso height	48.49	2	1.45
Brachial index	77.39	8	2.23
Crural index	85.19	7	1.61
Relative upper limb/ torso height	143.80	2	2.22
Interlimb index	70.36	7	1.38
Upper body width	347.91	3	35.34
Bi-iliac breadth	270.00	4	9.45
Lower limb length	770.28	7	46.06
Stature (Fully)	154.45	1	
Body Mass (FHD)	59.00	8	6.68
FEMALES			
Cranial index			
Cranial module	145.11	3	4.55
Facial index	158.83	2	4.26
Nasal index	92.85	2	7.81
Relative torso height	47.47	2	0.30
Brachial index	77.09	3	2.07
Crural index	84.76	4	1.23
Relative upper limb/ torso height	143.46	2	0.79
Interlimb index	67.81	3	0.76
Upper body width			
Bi-iliac breadth	265.00	4	4.24
Lower limb length	751.89	4	20.42
Stature (Fully)	156.11	2	4.87
Body Mass (FHD)	53.03	4	2.90

HAWIKUH

Dimension	Mean	N	Std. Dev.
MALES			
Cranial index	77.12	13	3.07
Cranial module	144.36	13	3.35
Facial index	165.28	14	8.28
Nasal index	81.22	14	9.15
Relative torso height	47.64	10	1.23
Brachial index	77.92	25	2.03
Crural index	84.89	25	1.77
Relative upper limb/ torso height	147.16	11	4.01
Interlimb index	69.77	23	1.38
Upper body width	326.02	10	26.03
Bi-iliac breadth	263.96	27	10.74
Lower limb length	776.03	25	42.45
Stature (Fully)	160.03	8	3.48
Body Mass (FHD)	59.08	29	4.66
FEMALES			
Cranial index	81.96	16	5.74
Cranial module	138.87	23	2.56
Facial index	170.45	24	11.32
Nasal index	92.28	25	10.83
Relative torso height	47.83	22	1.71
Brachial index	77.12	39	2.47
Crural index	84.39	40	2.21
Relative upper limb/ torso height	145.54	21	6.06
Interlimb index	69.87	38	1.10
Upper body width	291.51	19	10.86
Bi-iliac breadth	258.65	39	12.79
Lower limb length	722.80	39	29.53
Stature (Fully)	149.79	16	3.36
Body Mass (FHD)	50.01	42	4.08

MIMBRES

Dimension	Mean	N	Std. Dev.
MALES			
Cranial index	77.19	1	
Cranial module	150.34	5	4.13
Facial index	169.21	3	7.64
Nasal index	97.84	3	4.74
Relative torso height	47.45	4	2.04
Brachial index	78.66	7	1.85
Crural index	85.12	9	1.49
Relative upper limb/ torso height	148.05	4	4.99
Interlimb index	70.58	7	2.21
Upper body width	328.03	4	5.10
Bi-iliac breadth	266.14	7	7.73
Lower limb length	789.36	9	18.55
Stature (Fully)	160.25	3	4.46
Body Mass (FHD)	63.90	9	2.78
FEMALES			
Cranial index			
Cranial module			
Facial index			
Nasal index			
Relative torso height	46.05	1	
Brachial index	76.96	4	1.92
Crural index	86.36	5	0.43
Relative upper limb/ torso height	146.05	1	
Interlimb index	69.00	4	1.19
Upper body width	322.43	1	
Bi-iliac breadth	277.00	2	9.90
Lower limb length	768.71	5	28.73
Stature (Fully)			
Body Mass (FHD)	52.80	5	5.31

PAA-KO

Dimension	Mean	N	Std. Dev.
MALES			
Cranial index	90.48	1	
Cranial module	149.20	10	5.67
Facial index	174.04	9	9.61
Nasal index	92.50	8	3.60
Relative torso height	46.81	7	1.66
Brachial index	76.80	12	2.65
Crural index	85.45	12	1.17
Relative upper limb/ torso height	150.99	6	5.55
Interlimb index	70.61	9	0.88
Upper body width	339.28	7	14.71
Bi-iliac breadth	272.56	8	12.48
Lower limb length	789.61	11	33.01
Stature (Fully)	160.47	6	2.79
Body Mass (FHD)	62.49	12	5.02
FEMALES			
Cranial index	86.23	1	
Cranial module	145.67	10	4.98
Facial index	166.25	10	11.81
Nasal index	96.88	6	4.98
Relative torso height	48.77	10	1.53
Brachial index	75.46	14	1.98
Crural index	84.04	12	1.74
Relative upper limb/ torso height	143.97	11	6.14
Interlimb index	70.58	12	1.59
Upper body width	285.74	5	9.33
Bi-iliac breadth	265.12	13	7.98
Lower limb length	714.92	12	19.33
Stature (Fully)	150.30	7	2.20
Body Mass (FHD)	51.27	14	3.97

POTTERY MOUND

Dimension	Mean	N	Std. Dev.
MALES			
Cranial index			
Cranial module	149.41	13	5.60
Facial index	167.13	14	12.39
Nasal index	90.22	16	7.47
Relative torso height	47.09	15	1.85
Brachial index	78.21	24	1.28
Crural index	85.13	23	1.76
Relative upper limb/ torso height	147.15	16	5.77
Interlimb index	69.84	23	1.46
Upper body width	324.28	10	16.44
Bi-iliac breadth	263.53	18	9.95
Lower limb length	778.93	23	31.74
Stature (Fully)	159.42	10	5.45
Body Mass (FHD)	59.59	24	4.65
FEMALES			
Cranial index	81.10	1	
Cranial module	143.15	9	3.86
Facial index	169.14	8	12.12
Nasal index	95.21	8	6.62
Relative torso height	48.51	11	2.15
Brachial index	77.16	17	1.38
Crural index	84.46	17	1.56
Relative upper limb/ torso height	144.45	11	5.54
Interlimb index	69.88	17	1.61
Upper body width	289.95	11	8.45
Bi-iliac breadth	257.23	13	12.20
Lower limb length	720.49	17	23.77
Stature (Fully)	149.35	5	0.91
Body Mass (FHD)	50.87	17	2.99

PUYE

Dimension	Mean	N	Std. Dev.
MALES			
Cranial index	83.34	2	4.72
Cranial module	145.47	10	3.85
Facial index	173.48	8	5.56
Nasal index	78.34	7	5.97
Relative torso height	44.71	9	1.89
Brachial index	77.06	17	1.91
Crural index	84.54	17	2.05
Relative upper limb/ torso height	156.48	9	6.25
Interlimb index	69.88	17	1.35
Upper body width	319.08	6	15.65
Bi-iliac breadth	264.82	17	16.57
Lower limb length	766.00	17	42.54
Stature (Fully)	155.79	7	4.24
Body Mass (FHD)	57.29	17	6.11
FEMALES			
Cranial index	86.00	5	2.82
Cranial module	140.00	10	4.28
Facial index	166.74	10	13.32
Nasal index	77.84	8	6.05
Relative torso height	47.05	9	2.34
Brachial index	76.16	20	1.39
Crural index	84.43	22	2.42
Relative upper limb/ torso height	147.06	8	7.79
Interlimb index	69.75	20	1.44
Upper body width	283.19	3	12.86
Bi-iliac breadth	251.98	23	10.54
Lower limb length	714.13	22	22.16
Stature (Fully)	147.85	5	2.51
Body Mass (FHD)	48.03	23	3.34

FORT ANCIENT

Dimension	Mean	N	Std. Dev.
MALES			
Cranial index	77.61	12	3.58
Cranial module	151.38	13	4.74
Facial index	165.43	11	10.52
Nasal index	91.74	10	3.05
Relative torso height	47.83	12	2.42
Brachial index	78.00	15	1.90
Crural index	85.08	15	1.66
Relative upper limb/ torso height	147.13	12	7.45
Interlimb index	70.19	15	1.52
Upper body width	347.87	10	16.23
Bi-iliac breadth	270.10	15	10.53
Lower limb length	826.67	15	22.90
Stature (Fully)	167.86	10	2.36
Body Mass (FHD)	70.05	15	6.19
FEMALES			
Cranial index	75.72	2	1.21
Cranial module	147.08	4	3.21
Facial index	168.55	3	12.14
Nasal index	85.12	4	7.13
Relative torso height	49.50	5	2.76
Brachial index	76.25	7	2.04
Crural index	83.36	8	1.18
Relative upper limb/ torso height	141.86	5	10.67
Interlimb index	69.88	7	1.19
Upper body width	298.92	3	8.02
Bi-iliac breadth	264.58	6	7.95
Lower limb length	757.38	8	24.47
Stature (Fully)	159.21	4	3.13
Body Mass (FHD)	57.62	8	3.73

LIBBEN

Dimension	Mean	N	Std. Dev.
MALES			
Cranial index	74.89	14	3.95
Cranial module	156.98	14	5.55
Facial index	166.57	14	10.08
Nasal index	82.58	13	7.21
Relative torso height	45.58	8	1.37
Brachial index	79.77	22	2.54
Crural index	85.54	20	1.83
Relative upper limb/ torso height	157.40	6	4.79
Interlimb index	71.10	18	1.70
Upper body width	345.88	17	16.93
Bi-iliac breadth	271.91	16	17.54
Lower limb length	848.87	20	30.96
Stature (Fully)	167.33	4	1.61
Body Mass (FHD)	67.58	22	3.21
FEMALES			
Cranial index	76.10	14	3.30
Cranial module	149.95	13	4.11
Facial index	172.92	14	14.12
Nasal index	89.52	10	9.22
Relative torso height	46.18	13	1.70
Brachial index	78.85	20	2.37
Crural index	84.22	22	2.36
Relative upper limb/ torso height	153.01	12	5.72
Interlimb index	70.91	16	1.30
Upper body width	310.12	9	9.84
Bi-iliac breadth	264.56	16	12.23
Lower limb length	777.72	22	22.79
Stature (Fully)	156.99	6	4.49
Body Mass (FHD)	56.42	23	4.49

MADISONVILLE

Dimension	Mean	N	Std. Dev.
MALES			
Cranial index	84.78	12	4.34
Cranial module	153.33	12	3.12
Facial index	179.16	11	7.96
Nasal index	91.06	10	5.57
Relative torso height	47.77	12	2.39
Brachial index	78.63	19	1.90
Crural index	84.66	19	2.28
Relative upper limb/ torso height	145.86	12	5.77
Interlimb index	69.17	19	1.54
Upper body width	330.80	12	13.02
Bi-iliac breadth	273.03	15	15.82
Lower limb length	814.00	19	44.20
Stature (Fully)	165.29	8	4.81
Body Mass (FHD)	68.34	19	5.05
FEMALES			
Cranial index	86.05	10	3.49
Cranial module	149.70	10	4.37
Facial index	178.56	10	15.86
Nasal index	93.23	8	4.43
Relative torso height	49.18	9	2.73
Brachial index	77.58	19	1.86
Crural index	83.94	20	1.86
Relative upper limb/ torso height	140.61	9	9.00
Interlimb index	69.19	19	1.22
Upper body width	306.55	13	17.09
Bi-iliac breadth	262.87	19	9.84
Lower limb length	764.06	20	36.72
Stature (Fully)	158.52	7	5.14
Body Mass (FHD)	60.75	20	4.80

MOBRIDGE

Dimension	Mean	N	Std. Dev.
MALES			
Cranial index	80.36	17	4.22
Cranial module	150.35	18	3.29
Facial index	168.76	18	6.49
Nasal index	81.35	18	9.79
Relative torso height	46.95	17	1.73
Brachial index	78.92	23	2.53
Crural index	85.51	24	1.74
Relative upper limb/ torso height	148.30	16	5.01
Interlimb index	69.59	21	1.64
Upper body width	342.06	10	18.03
Bi-iliac breadth	281.83	21	16.41
Lower limb length	819.69	24	48.01
Stature (Fully)	168.89	15	5.09
Body Mass (FHD)	68.77	26	6.83
FEMALES			
Cranial index	82.12	13	4.26
Cranial module	144.10	13	4.00
Facial index	164.33	13	7.76
Nasal index	88.98	12	10.08
Relative torso height	48.46	12	2.37
Brachial index	78.72	14	2.27
Crural index	86.43	14	2.26
Relative upper limb/ torso height	145.15	12	7.32
Interlimb index	70.04	14	1.25
Upper body width	302.71	10	16.03
Bi-iliac breadth	271.83	12	19.55
Lower limb length	751.86	14	28.10
Stature (Fully)	154.76	11	3.92
Body Mass (FHD)	57.84	14	6.54

LARSON

Dimension	Mean	N	Std. Dev.
MALES			
Cranial index	76.80	14	3.32
Cranial module	150.55	14	1.64
Facial index	165.90	14	7.56
Nasal index	79.18	14	6.37
Relative torso height	47.51	10	1.68
Brachial index	79.10	16	2.88
Crural index	86.74	16	1.76
Relative upper limb/ torso height	146.51	10	4.66
Interlimb index	69.55	16	1.21
Upper body width	350.15	11	15.14
Bi-iliac breadth	281.23	13	12.54
Lower limb length	817.99	16	31.87
Stature (Fully)	165.22	9	5.22
Body Mass (FHD)	66.47	16	4.63
FEMALES			
Cranial index	78.27	14	3.34
Cranial module	144.52	14	3.52
Facial index	158.96	14	5.85
Nasal index	86.28	13	9.71
Relative torso height	47.51	13	2.64
Brachial index	78.25	16	2.28
Crural index	85.92	16	1.95
Relative upper limb/ torso height	147.42	13	6.85
Interlimb index	69.72	16	1.42
Upper body width	304.20	11	15.62
Bi-iliac breadth	269.75	16	13.58
Lower limb length	759.01	16	39.34
Stature (Fully)	153.63	11	5.01
Body Mass (FHD)	57.78	16	4.49

CHEYENNE RIVER SITES

Dimension	Mean	N	Std. Dev.
MALES			
Cranial index	79.39	10	3.82
Cranial module	146.43	10	1.98
Facial index	164.09	9	9.25
Nasal index	75.57	10	8.37
Relative torso height	46.05	8	1.15
Brachial index	79.67	14	2.11
Crural index	86.03	15	1.55
Relative upper limb/ torso height	149.50	8	3.29
Interlimb index	69.41	14	1.45
Upper body width	333.48	13	12.01
Bi-iliac breadth	277.60	15	10.12
Lower limb length	824.74	15	25.42
Stature (Fully)	168.90	7	3.00
Body Mass (FHD)	66.55	15	4.98
FEMALES			
Cranial index	78.71	5	3.00
Cranial module	144.73	5	1.79
Facial index	160.53	5	11.59
Nasal index	80.34	5	5.19
Relative torso height	47.39	6	2.81
Brachial index	77.85	8	1.12
Crural index	84.63	11	2.86
Relative upper limb/ torso height	147.61	5	9.80
Interlimb index	69.29	8	1.20
Upper body width	302.45	6	14.64
Bi-iliac breadth	261.38	8	9.21
Lower limb length	760.77	11	30.37
Stature (Fully)	154.03	5	4.29
Body Mass (FHD)	58.42	11	4.98

SULLY

Dimension	Mean	N	Std. Dev.
MALES			
Cranial index	80.25	10	4.97
Cranial module	149.81	9	4.37
Facial index	161.96	11	6.78
Nasal index	76.86	11	5.95
Relative torso height	47.39	8	1.78
Brachial index	79.28	12	1.51
Crural index	86.92	12	2.24
Relative upper limb/ torso height	148.15	8	6.25
Interlimb index	69.91	12	1.62
Upper body width	351.82	6	16.08
Bi-iliac breadth	279.46	12	11.10
Lower limb length	823.37	12	23.68
Stature (Fully)	168.04	8	3.99
Body Mass (FHD)	68.57	12	3.42
FEMALES			
Cranial index	80.12	6	3.04
Cranial module	143.11	6	3.93
Facial index	174.32	6	18.03
Nasal index	84.13	6	13.51
Relative torso height	48.05	5	1.80
Brachial index	78.84	7	1.05
Crural index	87.00	7	2.16
Relative upper limb/ torso height	144.86	5	5.24
Interlimb index	69.59	6	0.79
Upper body width	285.06	3	7.56
Bi-iliac breadth	258.81	8	15.05
Lower limb length	740.46	7	16.30
Stature (Fully)	152.95	4	1.67
Body Mass (FHD)	58.64	8	2.79

AVERBUCH

Dimension	Mean	N	Std. Dev.
MALES			
Cranial index	90.42	1	
Cranial module	151.82	19	3.74
Facial index	168.33	15	7.74
Nasal index	77.52	10	4.52
Relative torso height	47.75	15	2.02
Brachial index	78.04	26	1.54
Crural index	84.03	27	1.47
Relative upper limb/ torso height	148.05	15	5.28
Interlimb index	70.46	26	1.36
Upper body width	349.18	13	19.65
Bi-iliac breadth	275.40	25	15.94
Lower limb length	820.20	27	38.68
Stature (Fully)	169.62	13	5.60
Body Mass (FHD)	68.09	27	5.51
FEMALES			
Cranial index	97.33	1	
Cranial module	146.64	24	4.23
Facial index	168.01	24	8.91
Nasal index	89.09	13	8.10
Relative torso height	47.45	17	1.59
Brachial index	76.11	28	2.12
Crural index	83.41	28	2.30
Relative upper limb/ torso height	146.87	17	5.77
Interlimb index	69.71	28	1.59
Upper body width	319.89	15	18.10
Bi-iliac breadth	266.11	23	15.05
Lower limb length	767.95	28	42.78
Stature (Fully)	159.97	15	5.02
Body Mass (FHD)	56.62	28	6.12

CANDY CREEK & LEDBETTER LANDING

Dimension	Mean	N	Std. Dev.
MALES			
Cranial index	78.28	13	4.93
Cranial module	152.22	12	2.94
Facial index	176.63	9	9.12
Nasal index	93.93	8	12.28
Relative torso height	47.95	8	2.27
Brachial index	77.25	14	2.28
Crural index	85.43	12	1.56
Relative upper limb/ torso height	143.71	9	6.90
Interlimb index	69.31	11	1.56
Upper body width	325.13	7	18.14
Bi-iliac breadth	274.56	8	10.80
Lower limb length	814.07	11	26.32
Stature (Fully)	165.89	8	5.89
Body Mass (FHD)	64.53	14	3.46
FEMALES			
Cranial index	80.52	4	2.80
Cranial module	149.20	5	3.34
Facial index	170.42	3	2.40
Nasal index	93.80	3	1.73
Relative torso height	51.39	1	
Brachial index	75.89	4	2.78
Crural index	84.84	4	2.40
Relative upper limb/ torso height	134.77	1	
Interlimb index	70.13	4	1.40
Upper body width	302.04	1	
Bi-iliac breadth	259.25	2	0.35
Lower limb length	745.43	4	10.04
Stature (Fully)	156.63	1	
Body Mass (FHD)	55.63	4	1.55

CHERRY

Dimension	Mean	N	Std. Dev.
MALES			
Cranial index	75.53	12	2.83
Cranial module	152.26	10	2.80
Facial index	173.82	12	14.56
Nasal index	88.72	12	8.10
Relative torso height	47.28	11	2.16
Brachial index	77.90	15	1.85
Crural index	85.18	15	2.08
Relative upper limb/ torso height	149.45	11	8.19
Interlimb index	70.61	15	0.81
Upper body width	321.31	7	21.42
Bi-iliac breadth	255.58	13	11.01
Lower limb length	798.48	15	48.69
Stature (Fully)	159.83	9	4.25
Body Mass (FHD)	62.24	15	4.84
FEMALES			
Cranial index	75.36	5	2.74
Cranial module	146.20	5	3.39
Facial index	181.82	4	9.43
Nasal index	87.83	4	11.60
Relative torso height	47.09	2	2.16
Brachial index	75.45	5	1.72
Crural index	83.37	4	1.97
Relative upper limb/ torso height	149.00	2	1.57
Interlimb index	70.12	4	1.45
Upper body width	278.00	4	13.73
Bi-iliac breadth	247.83	3	5.06
Lower limb length	738.81	4	25.55
Stature (Fully)	150.91	2	4.35
Body Mass (FHD)	50.74	5	2.90

EBENEZER & ROBINSON

Dimension	Mean	N	Std. Dev.
MALES			
Cranial index	77.90	5	4.31
Cranial module	153.87	5	4.92
Facial index	183.32	1	
Nasal index	87.40	1	
Relative torso height	47.38	5	2.42
Brachial index	76.58	10	2.10
Crural index	85.57	11	2.32
Relative upper limb/ torso height	149.67	5	7.36
Interlimb index	70.10	10	1.69
Upper body width	319.84	5	22.71
Bi-iliac breadth	268.40	5	9.94
Lower limb length	821.16	11	53.40
Stature (Fully)	166.81	3	15.51
Body Mass (FHD)	61.51	11	6.88
FEMALES			
Cranial index	79.37	2	4.77
Cranial module	149.34	2	.94
Facial index			
Nasal index			
Relative torso height	47.51	2	1.21
Brachial index	77.16	5	2.27
Crural index	84.54	5	3.04
Relative upper limb/ torso height	147.45	2	3.23
Interlimb index	70.10	5	.22
Upper body width	322.80	2	13.80
Bi-iliac breadth	260.00	3	5.57
Lower limb length	774.45	5	38.58
Stature (Fully)	166.13	1	
Body Mass (FHD)	54.56	5	4.31

EVA

Dimension	Mean	N	Std. Dev.
MALES			
Cranial index	77.27	18	2.67
Cranial module	150.22	17	2.32
Facial index	176.26	17	11.35
Nasal index	88.79	17	7.50
Relative torso height	47.37	16	1.53
Brachial index	78.98	18	2.38
Crural index	84.06	18	2.15
Relative upper limb/ torso height	147.97	16	5.65
Interlimb index	69.87	18	1.27
Upper body width	320.58	7	23.22
Bi-iliac breadth	252.67	9	11.71
Lower limb length	788.72	18	45.86
Stature (Fully)	162.19	14	5.22
Body Mass (FHD)	61.90	19	6.01
FEMALES			
Cranial index	77.68	13	3.35
Cranial module	145.56	12	2.56
Facial index	171.67	12	11.58
Nasal index	91.55	12	7.04
Relative torso height	46.49	9	1.96
Brachial index	76.99	12	1.72
Crural index	84.27	12	2.02
Relative upper limb/ torso height	148.45	8	4.35
Interlimb index	69.78	11	1.31
Upper body width	293.56	8	20.36
Bi-iliac breadth	259.40	5	11.48
Lower limb length	747.71	12	40.80
Stature (Fully)	153.72	8	6.78
Body Mass (FHD)	52.72	13	4.15

HIWASSEE

Dimension	Mean	N	Std. Dev.
MALES			
Cranial index	73.40	1	
Cranial module	153.62	14	4.95
Facial index	166.32	8	5.58
Nasal index	84.64	7	7.89
Relative torso height	47.25	12	1.82
Brachial index	77.90	20	1.77
Crural index	83.88	19	2.52
Relative upper limb/ torso height	149.40	12	4.89
Interlimb index	70.72	19	1.66
Upper body width	330.52	14	19.65
Bi-iliac breadth	271.90	15	13.78
Lower limb length	809.20	19	44.47
Stature (Fully)	168.20	9	6.69
Body Mass (FHD)	66.40	19	5.35
FEMALES			
Cranial index	85.98	2	1.21
Cranial module	148.46	15	3.83
Facial index	166.45	13	5.45
Nasal index	87.62	8	3.11
Relative torso height	48.21	15	2.04
Brachial index	76.08	20	2.51
Crural index	83.01	18	2.27
Relative upper limb/ torso height	146.50	15	7.57
Interlimb index	70.62	18	1.10
Upper body width	304.13	14	17.52
Bi-iliac breadth	264.82	14	13.56
Lower limb length	752.23	18	26.06
Stature (Fully)	156.46	11	4.23
Body Mass (FHD)	54.71	19	3.99

LEDFORD LANDING

Dimension	Mean	N	Std. Dev.
MALES			
Cranial index	81.76	6	7.19
Cranial module	151.62	13	3.61
Facial index	174.03	13	9.86
Nasal index	89.54	12	8.20
Relative torso height	47.03	8	1.83
Brachial index	78.11	21	2.60
Crural index	84.34	22	1.79
Relative upper limb/ torso height	150.82	8	7.14
Interlimb index	70.01	21	1.63
Upper body width	325.17	10	11.35
Bi-iliac breadth	269.88	12	13.51
Lower limb length	816.73	22	27.82
Stature (Fully)	165.43	5	4.28
Body Mass (FHD)	63.85	22	4.58
FEMALES			
Cranial index			
Cranial module	146.42	16	3.64
Facial index	177.23	14	17.63
Nasal index	94.42	11	4.82
Relative torso height	48.33	9	2.19
Brachial index	76.28	20	1.66
Crural index	83.93	21	1.39
Relative upper limb/ torso height	145.21	8	5.92
Interlimb index	69.75	19	0.88
Upper body width	290.86	12	18.83
Bi-iliac breadth	259.32	11	14.90
Lower limb length	747.11	21	22.78
Stature (Fully)	154.12	5	2.71
Body Mass (FHD)	53.14	21	4.10

THOMSPON VILLAGE

Dimension	Mean	N	Std. Dev.
MALES			
Cranial index	153.61	6	2.64
Cranial module	171.11	5	6.22
Facial index	85.79	3	2.51
Nasal index	49.63	4	0.95
Relative torso height	76.32	11	2.39
Brachial index	84.14	12	2.29
Crural index	143.91	4	2.37
Relative upper limb/ torso height	70.41	10	2.57
Interlimb index	339.30	5	12.04
Upper body width	274.57	7	12.84
Bi-iliac breadth	790.33	12	30.50
Lower limb length	164.07	2	7.01
Stature (Fully)	65.59	12	5.87
Body Mass (FHD)	153.61	6	2.64
FEMALES			
Cranial index	83.96	2	7.38
Cranial module	145.39	6	3.95
Facial index	172.98	4	5.69
Nasal index	91.76	2	2.60
Relative torso height	51.49	2	1.07
Brachial index	75.89	12	2.68
Crural index	83.69	13	2.26
Relative upper limb/ torso height	139.43	2	0.88
Interlimb index	71.27	12	1.23
Upper body width	302.82	8	16.32
Bi-iliac breadth	255.00	10	13.17
Lower limb length	734.68	13	32.93
Stature (Fully)	159.34	1	
Body Mass (FHD)	53.07	13	3.63

TOQUA

Dimension	Mean	N	Std. Dev.
MALES			
Cranial index	77.03	5	2.63
Cranial module	151.17	12	3.41
Facial index	167.59	5	14.50
Nasal index	97.32	8	3.23
Relative torso height	48.39	12	1.69
Brachial index	76.06	17	2.16
Crural index	83.61	18	1.28
Relative upper limb/ torso height	145.07	11	6.38
Interlimb index	70.26	17	1.19
Upper body width	319.71	11	17.66
Bi-iliac breadth	271.91	11	12.94
Lower limb length	800.14	18	29.44
Stature (Fully)	164.37	9	6.08
Body Mass (FHD)	64.57	18	6.42
FEMALES			
Cranial index	78.49	4	5.06
Cranial module	147.17	10	4.23
Facial index	172.31	8	11.01
Nasal index	93.85	10	6.10
Relative torso height	47.94	13	1.86
Brachial index	75.93	19	1.95
Crural index	83.02	18	2.42
Relative upper limb/ torso height	145.86	14	6.33
Interlimb index	70.15	18	1.68
Upper body width	305.39	9	13.91
Bi-iliac breadth	261.54	13	16.22
Lower limb length	762.05	18	43.15
Stature (Fully)	157.77	8	4.72
Body Mass (FHD)	55.46	19	4.84

CAPLEN

Dimension	Mean	N	Std. Dev.
MALES			
Cranial index	77.97	6	2.75
Cranial module	151.14	7	4.78
Facial index	162.98	5	5.41
Nasal index	84.06	4	11.34
Relative torso height	44.96	1	
Brachial index	80.37	3	1.45
Crural index	84.11	4	1.15
Relative upper limb/ torso height	160.05	1	
Interlimb index	71.48	3	1.92
Upper body width	331.62	1	
Bi-iliac breadth	267.50	2	3.54
Lower limb length	786.67	3	28.38
Stature (Fully)	164.13	1	
Body Mass (FHD)	62.29	4	5.53
FEMALES			
Cranial index	76.87	4	0.64
Cranial module	149.83	4	1.45
Facial index	174.29	3	2.02
Nasal index	90.74	2	2.57
Relative torso height	47.43	1	
Brachial index	76.67	4	2.12
Crural index	84.72	4	1.68
Relative upper limb/ torso height	146.74	1	
Interlimb index	69.35	4	0.23
Upper body width			
Bi-iliac breadth	264.00	1	
Lower limb length	766.61	4	14.79
Stature (Fully)	155.28	1	
Body Mass (FHD)	53.63	4	1.83

ERNEST WHITTE

Dimension	Mean	N	Std. Dev.
MALES			
Cranial index	81.55	1	
Cranial module	145.00	1	
Facial index			
Nasal index	97.41	1	
Relative torso height			
Brachial index	77.67	6	1.69
Crural index	82.58	3	3.84
Relative upper limb/ torso height			
Interlimb index	73.57	2	2.87
Upper body width			
Bi-iliac breadth	244.00	1	
Lower limb length	825.22	3	49.28
Stature (Fully)			
Body Mass (FHD)	69.51	6	5.45
FEMALES			
Cranial index	72.50	3	4.10
Cranial module	149.44	3	2.99
Facial index	181.97	1	
Nasal index	88.16	1	
Relative torso height			
Brachial index	77.71	4	2.58
Crural index	84.77	1	
Relative upper limb/ torso height			
Interlimb index	69.55	1	
Upper body width			
Bi-iliac breadth			
Lower limb length	724.67	1	
Stature (Fully)			
Body Mass (FHD)	53.79	2	10.52

LOEVE FOX & FATE BELL SHELTER

Dimension	Mean	N	Std. Dev.
MALES			
Cranial index	69.99	9	2.90
Cranial module	152.11	9	2.84
Facial index	165.43	6	8.36
Nasal index	90.91	2	0.40
Relative torso height	45.52	7	0.87
Brachial index	78.68	10	2.47
Crural index	85.56	11	1.75
Relative upper limb/ torso height	152.77	7	4.27
Interlimb index	69.97	10	1.68
Upper body width	332.06	3	16.70
Bi-iliac breadth	267.25	8	13.79
Lower limb length	834.64	11	32.58
Stature (Fully)	168.97	6	5.46
Body Mass (FHD)	65.56	11	3.62
FEMALES			
Cranial index	69.03	7	2.31
Cranial module	144.76	7	2.05
Facial index	171.90	5	6.94
Nasal index	94.49	2	.18
Relative torso height	46.46	3	2.30
Brachial index	77.32	6	3.02
Crural index	86.02	6	1.56
Relative upper limb/ torso height	148.95	3	8.57
Interlimb index	68.93	6	1.40
Upper body width	299.32	2	5.40
Bi-iliac breadth	265.25	6	10.33
Lower limb length	788.75	6	23.87
Stature (Fully)	155.57	3	2.60
Body Mass (FHD)	55.07	6	3.17

MITCHELL

Dimension	Mean	N	Std. Dev.
MALES			
Cranial index	76.79	10	2.79
Cranial module	153.53	10	5.17
Facial index	164.81	10	11.91
Nasal index	88.95	8	7.88
Relative torso height	44.81	6	2.66
Brachial index	78.32	10	1.86
Crural index	85.97	10	1.77
Relative upper limb/ torso height	153.34	6	10.00
Interlimb index	68.36	10	1.21
Upper body width	336.59	5	20.08
Bi-iliac breadth	281.75	8	13.91
Lower limb length	836.63	10	34.92
Stature (Fully)	169.43	5	6.05
Body Mass (FHD)	66.05	10	6.77
FEMALES			
Cranial index	78.58	6	3.95
Cranial module	148.13	5	3.26
Facial index	169.44	5	7.99
Nasal index	94.25	5	2.56
Relative torso height	47.33	4	1.17
Brachial index	78.70	8	1.67
Crural index	84.58	7	1.80
Relative upper limb/ torso height	145.28	4	4.71
Interlimb index	69.49	7	1.91
Upper body width	305.07	3	10.35
Bi-iliac breadth	258.80	5	6.38
Lower limb length	763.74	7	21.21
Stature (Fully)	156.96	3	.52
Body Mass (FHD)	55.24	9	5.35

CALDWELL VILLAGE

Dimension	Mean	N	Std. Dev.
MALES			
Cranial index			
Cranial module	151.11	3	8.00
Facial index	171.11	3	12.43
Nasal index	89.92	3	5.11
Relative torso height	49.05	2	1.08
Brachial index	77.74	5	0.95
Crural index	85.41	3	2.46
Relative upper limb/ torso height	144.40	2	1.55
Interlimb index	70.96	3	0.62
Upper body width	338.80	1	
Bi-iliac breadth	256.50	2	19.09
Lower limb length	768.73	3	61.36
Stature (Fully)	159.60	2	14.17
Body Mass (FHD)	56.96	3	8.67
FEMALES			
Cranial index			
Cranial module	140.45	3	6.67
Facial index	177.01	3	21.59
Nasal index	95.95	3	5.65
Relative torso height	49.02	1	
Brachial index	73.95	3	1.00
Crural index	84.42	4	1.64
Relative upper limb/ torso height	145.24	1	
Interlimb index	71.83	3	0.55
Upper body width	288.71	2	2.21
Bi-iliac breadth	251.50	4	15.42
Lower limb length	689.94	4	15.84
Stature (Fully)	141.18	1	
Body Mass (FHD)	48.88	4	2.51

DUNA LEYENDA

Dimension	Mean	N	Std. Dev.
MALES			
Cranial index	75.41	4	5.11
Cranial module	147.84	4	2.59
Facial index	169.25	4	7.03
Nasal index	83.61	3	2.29
Relative torso height			
Brachial index	77.14	3	0.77
Crural index	84.56	3	2.07
Relative upper limb/ torso height			
Interlimb index	71.32	2	0.76
Upper body width	337.64	2	11.21
Bi-iliac breadth	267.75	2	1.77
Lower limb length	756.60	3	25.47
Stature (Fully)			
Body Mass (FHD)	62.74	3	5.04
FEMALES			
Cranial index	74.41	2	4.32
Cranial module	144.84	2	3.06
Facial index	165.67	2	5.05
Nasal index	92.71	2	6.97
Relative torso height	51.71	2	3.85
Brachial index	75.47	2	1.49
Crural index	85.75	2	2.20
Relative upper limb/ torso height	134.46	2	10.31
Interlimb index	69.32	2	0.16
Upper body width	273.26	1	
Bi-iliac breadth	255.50	2	7.78
Lower limb length	687.68	2	23.95
Stature (Fully)	147.20	2	0.67
Body Mass (FHD)	52.47	2	1.23

EVANS AND PAROGONAH MOUNDS

Dimension	Mean	N	Std. Dev.
MALES			
Cranial index	83.60	3	1.60
Cranial module	152.20	5	5.43
Facial index	173.20	5	7.54
Nasal index	92.47	5	5.27
Relative torso height	51.34	1	
Brachial index	81.27	2	1.64
Crural index	84.78	3	1.36
Relative upper limb/ torso height	137.93	1	
Interlimb index	71.30	2	0.70
Upper body width	319.07	2	22.38
Bi-iliac breadth	263.00	3	5.89
Lower limb length	761.84	3	11.94
Stature (Fully)	162.60	1	
Body Mass (FHD)	63.85	3	3.19
FEMALES			
Cranial index			
Cranial module	141.89	3	3.34
Facial index	178.12	3	5.09
Nasal index	101.84	3	9.26
Relative torso height			
Brachial index	76.35	2	1.67
Crural index	84.38	1	
Relative upper limb/ torso height			
Interlimb index	71.07	1	
Upper body width	293.41	1	
Bi-iliac breadth	265.00	4	12.19
Lower limb length	734.50	1	
Stature (Fully)			
Body Mass (FHD)	54.04	1	

GLEN CANYON

Dimension	Mean	N	Std. Dev.
MALES			
Cranial index	75.67	21	5.58
Cranial module	148.30	28	3.38
Facial index	169.15	33	11.74
Nasal index	88.96	32	7.99
Relative torso height	46.61	12	2.39
Brachial index	78.76	37	2.40
Crural index	86.64	33	2.30
Relative upper limb/ torso height	148.32	12	5.77
Interlimb index	69.52	29	1.59
Upper body width	327.69	12	13.83
Bi-iliac breadth	267.57	30	12.29
Lower limb length	802.90	33	32.38
Stature (Fully)	161.76	9	2.56
Body Mass (FHD)	62.39	39	5.00
FEMALES			
Cranial index	76.77	12	6.92
Cranial module	144.32	19	3.43
Facial index	169.58	18	10.40
Nasal index	92.58	19	7.54
Relative torso height	47.46	8	2.96
Brachial index	77.27	29	1.82
Crural index	85.22	26	1.78
Relative upper limb/ torso height	145.10	11	8.70
Interlimb index	69.71	24	1.45
Upper body width	297.63	13	11.60
Bi-iliac breadth	260.37	26	12.59
Lower limb length	743.59	26	25.26
Stature (Fully)	152.22	5	2.90
Body Mass (FHD)	51.73	31	3.12

POLLEY-SECRET

Dimension	Mean	N	Std. Dev.
MALES			
Cranial index			
Cranial module	149.93	5	3.97
Facial index	172.67	4	4.67
Nasal index	96.60	4	5.95
Relative torso height	49.81	5	1.47
Brachial index	78.97	6	1.51
Crural index	86.52	6	1.27
Relative upper limb/ torso height	140.78	5	4.95
Interlimb index	70.14	6	0.89
Upper body width	341.22	2	17.83
Bi-iliac breadth	263.17	6	12.29
Lower limb length	770.36	6	23.29
Stature (Fully)	159.08	4	3.33
Body Mass (FHD)	62.17	6	3.21
FEMALES			
Cranial index			
Cranial module	147.67	2	10.37
Facial index	172.24	2	6.12
Nasal index	103.95	2	7.53
Relative torso height			
Brachial index	81.45	1	
Crural index	85.40	1	
Relative upper limb/ torso height			
Interlimb index	71.97	1	
Upper body width			
Bi-iliac breadth			
Lower limb length	747.50	1	
Stature (Fully)			
Body Mass (FHD)	54.87	1	

PRINCE RUPERT HARBOUR

Dimension	Mean	N	Std. Dev.
MALES			
Cranial index	75.57	38	3.91
Cranial module	156.58	38	3.67
Facial index	174.26	31	13.96
Nasal index	84.95	15	7.39
Relative torso height	49.92	23	2.37
Brachial index	77.95	37	2.29
Crural index	82.82	40	2.08
Relative upper limb/ torso height	145.84	23	5.63
Interlimb index	72.60	39	1.59
Upper body width	336.79	17	16.08
Bi-iliac breadth	276.74	21	9.82
Lower limb length	758.33	40	26.83
Stature (Fully)	158.52	22	4.03
Body Mass (FHD)	69.50	41	5.27
FEMALES			
Cranial index	78.98	15	3.40
Cranial module	148.31	14	3.35
Facial index	173.27	12	8.01
Nasal index	86.34	6	5.91
Relative torso height	50.50	11	1.35
Brachial index	75.10	17	2.66
Crural index	81.93	16	2.17
Relative upper limb/ torso height	140.18	13	5.69
Interlimb index	70.65	16	2.68
Upper body width	295.45	9	15.14
Bi-iliac breadth	264.94	9	17.30
Lower limb length	705.85	16	37.76
Stature (Fully)	147.85	10	4.67
Body Mass (FHD)	57.24	18	5.47

COAST SALISH

Dimension	Mean	N	Std. Dev.
MALES			
Cranial index	80.85	4	2.42
Cranial module	145.67	6	4.01
Facial index	175.13	6	14.11
Nasal index	91.84	6	7.65
Relative torso height	47.15	7	2.13
Brachial index	77.97	10	2.16
Crural index	82.79	10	0.89
Relative upper limb/ torso height	149.86	7	9.04
Interlimb index	70.54	10	1.83
Upper body width	315.61	9	19.13
Bi-iliac breadth	266.19	8	10.60
Lower limb length	769.13	10	21.76
Stature (Fully)	156.99	4	3.61
Body Mass (FHD)	63.96	10	5.04
FEMALES			
Cranial index	79.31	5	5.54
Cranial module	144.13	5	2.29
Facial index	163.94	5	13.11
Nasal index	80.86	5	8.31
Relative torso height	46.64	3	1.86
Brachial index	78.44	5	1.37
Crural index	83.58	5	2.34
Relative upper limb/ torso height	151.69	3	9.50
Interlimb index	70.57	5	1.23
Upper body width	313.02	4	19.65
Bi-iliac breadth	255.75	4	15.97
Lower limb length	742.95	5	37.16
Stature (Fully)	148.45	3	6.41
Body Mass (FHD)	55.48	5	5.78

KWAKIUTL

Dimension	Mean	N	Std. Dev.
MALES			
Cranial index	79.20	7	5.28
Cranial module	150.51	19	5.31
Facial index	170.08	20	13.92
Nasal index	86.91	19	9.19
Relative torso height	50.10	15	1.73
Brachial index	77.30	28	2.49
Crural index	82.91	26	1.43
Relative upper limb/ torso height	144.03	16	5.10
Interlimb index	72.38	25	1.55
Upper body width	329.89	17	21.45
Bi-iliac breadth	264.71	21	12.65
Lower limb length	753.18	26	33.23
Stature (Fully)	157.66	10	4.39
Body Mass (FHD)	63.20	28	5.85
FEMALES			
Cranial index	81.30	6	6.66
Cranial module	144.88	11	3.20
Facial index	161.38	10	10.99
Nasal index	91.31	9	4.81
Relative torso height	49.96	6	3.74
Brachial index	76.37	12	0.89
Crural index	82.41	14	1.23
Relative upper limb/ torso height	140.50	6	7.45
Interlimb index	70.43	12	3.08
Upper body width	301.55	7	15.58
Bi-iliac breadth	253.50	12	12.03
Lower limb length	708.73	14	32.62
Stature (Fully)	149.83	6	3.07
Body Mass (FHD)	55.19	14	3.31

NOOTKA

Dimension	Mean	N	Std. Dev.
MALES			
Cranial index	81.25	1	
Cranial module	147.78	6	3.30
Facial index	157.55	6	5.72
Nasal index	86.86	6	7.13
Relative torso height	46.62	1	
Brachial index	74.32	5	3.59
Crural index	82.41	2	2.03
Relative upper limb/ torso height	145.32	2	8.35
Interlimb index	73.39	3	3.90
Upper body width	312.45	4	12.17
Bi-iliac breadth	269.75	2	14.50
Lower limb length	712.33	3	12.39
Stature (Fully)	146.31	1	
Body Mass (FHD)	59.85	5	6.73
FEMALES			
Cranial index	75.69	2	5.59
Cranial module	144.58	4	2.73
Facial index	162.54	4	17.75
Nasal index	84.38	3	3.50
Relative torso height	49.73	1	
Brachial index	75.56	4	3.34
Crural index	84.18	4	1.99
Relative upper limb/ torso height	145.18	1	
Interlimb index	74.23	3	3.15
Upper body width	306.43	3	11.73
Bi-iliac breadth	249.50	4	21.08
Lower limb length	691.13	4	67.53
Stature (Fully)	158.36	1	
Body Mass (FHD)	51.45	5	6.45

SOURIS RIVER

Dimension	Mean	N	Std. Dev.
MALES			
Cranial index	75.01	6	2.78
Cranial module	152.67	6	4.01
Facial index	174.45	6	11.10
Nasal index	89.26	4	11.59
Relative torso height	45.59	2	0.18
Brachial index	79.82	6	2.93
Crural index	85.10	9	1.66
Relative upper limb/ torso height	157.63	3	5.74
Interlimb index	70.85	6	1.29
Upper body width	377.22	2	7.98
Bi-iliac breadth	282.89	9	16.67
Lower limb length	847.43	9	45.19
Stature (Fully)	170.82	2	9.55
Body Mass (FHD)	72.18	10	3.63
FEMALES			
Cranial index	74.64	3	1.55
Cranial module	148.56	3	1.71
Facial index	171.22	3	1.53
Nasal index	82.71	2	4.46
Relative torso height			
Brachial index	77.21	3	1.85
Crural index	84.41	4	0.94
Relative upper limb/ torso height			
Interlimb index	69.62	4	1.21
Upper body width			
Bi-iliac breadth	277.50	3	9.73
Lower limb length	758.71	4	22.47
Stature (Fully)			
Body Mass (FHD)	62.35	4	4.84

SNOWFLAKE

Dimension	Mean	N	Std. Dev.
MALES			
Cranial index	73.66	3	2.61
Cranial module	153.00	3	4.62
Facial index	169.16	4	14.02
Nasal index	88.77	4	14.98
Relative torso height			
Brachial index	79.35	4	3.28
Crural index	82.47	4	3.68
Relative upper limb/ torso height			
Interlimb index	71.32	4	3.00
Upper body width	348.87	3	17.76
Bi-iliac breadth	310.00	1	
Lower limb length	823.81	4	39.17
Stature (Fully)			
Body Mass (FHD)	68.60	3	3.85
FEMALES			
Cranial index			
Cranial module			
Facial index			
Nasal index			
Relative torso height	46.88	1	
Brachial index	76.99	2	0.45
Crural index	85.07	2	2.81
Relative upper limb/ torso height	145.62	1	
Interlimb index	68.41	2	0.19
Upper body width	284.50	1	
Bi-iliac breadth			
Lower limb length	789.13	2	52.86
Stature (Fully)			
Body Mass (FHD)	60.15	2	4.35

CHESTERFIELD INLET

Dimension	Mean	N	Std. Dev.
MALES			
Cranial index	72.16	15	2.75
Cranial module	152.58	15	3.96
Facial index	169.71	14	13.93
Nasal index	74.10	15	6.24
Relative torso height	45.17	7	1.74
Brachial index	73.81	14	2.94
Crural index	81.67	14	2.27
Relative upper limb/ torso height	152.14	7	5.69
Interlimb index	68.34	14	1.37
Upper body width	331.79	6	17.89
Bi-iliac breadth	274.00	12	18.95
Lower limb length	780.17	14	21.79
Stature (Fully)	158.06	7	5.90
Body Mass (FHD)	71.94	14	7.71
FEMALES			
Cranial index	74.16	7	2.94
Cranial module	145.76	7	4.94
Facial index	168.34	7	11.08
Nasal index	77.88	7	4.32
Relative torso height	43.99	1	
Brachial index	71.51	8	1.13
Crural index	80.87	8	2.09
Relative upper limb/ torso height	155.21	1	
Interlimb index	65.66	8	1.21
Upper body width	293.00	2	28.25
Bi-iliac breadth	264.00	7	19.14
Lower limb length	743.07	8	23.41
Stature (Fully)	150.55	1	
Body Mass (FHD)	63.99	8	5.97

SADLERMIUT

Dimension	Mean	N	Std. Dev.
MALES			
Cranial index	73.84	27	2.62
Cranial module	154.16	27	2.71
Facial index	168.76	27	10.44
Nasal index	70.44	27	6.30
Relative torso height	46.09	24	2.69
Brachial index	71.97	30	2.73
Crural index	80.49	28	1.80
Relative upper limb/ torso height	146.70	25	8.33
Interlimb index	67.33	28	1.23
Upper body width	314.59	22	14.64
Bi-iliac breadth	273.09	27	12.83
Lower limb length	779.96	28	41.02
Stature (Fully)	158.74	22	5.69
Body Mass (FHD)	73.20	28	5.08
FEMALES			
Cranial index	73.81	23	2.73
Cranial module	148.58	23	3.51
Facial index	170.82	22	9.80
Nasal index	75.91	21	7.50
Relative torso height	47.75	16	2.48
Brachial index	70.80	27	1.97
Crural index	80.39	26	2.01
Relative upper limb/ torso height	141.39	17	7.43
Interlimb index	67.35	26	1.44
Upper body width	287.16	16	12.71
Bi-iliac breadth	270.50	25	13.64
Lower limb length	723.31	26	44.79
Stature (Fully)	151.07	14	7.07
Body Mass (FHD)	62.48	26	4.23

DONALDSON

Dimension	Mean	N	Std. Dev.
MALES			
Cranial index	76.97	4	2.04
Cranial module	153.50	4	2.12
Facial index	171.32	4	10.26
Nasal index	68.02	1	
Relative torso height	45.70	2	2.21
Brachial index	78.14	5	1.09
Crural index	84.16	4	2.76
Relative upper limb/ torso height	157.11	3	8.73
Interlimb index	69.64	4	0.54
Upper body width	371.07	3	5.70
Bi-iliac breadth	295.88	4	8.25
Lower limb length	892.25	4	22.70
Stature (Fully)	178.19	2	3.31
Body Mass (FHD)	70.69	5	5.26
FEMALES			
Cranial index	78.44	3	3.09
Cranial module	151.89	3	3.91
Facial index	177.77	3	10.72
Nasal index	79.49	1	
Relative torso height	42.74	1	
Brachial index	76.51	5	0.89
Crural index	83.94	5	1.39
Relative upper limb/ torso height	163.50	1	
Interlimb index	68.95	5	0.81
Upper body width	307.71	2	2.13
Bi-iliac breadth	281.25	4	21.87
Lower limb length	826.50	5	45.70
Stature (Fully)			
Body Mass (FHD)	62.76	5	3.18

ALTAR DE SACRIFICIOS

Dimension	Mean	N	Std. Dev.
MALES			
Cranial index	88.16	3	2.92
Cranial module	151.67	5	2.28
Facial index	170.14	4	8.69
Nasal index	92.37	4	3.41
Relative torso height			
Brachial index	77.55	7	1.83
Crural index	85.06	9	1.20
Relative upper limb/ torso height			
Interlimb index	70.43	6	1.24
Upper body width	326.28	1	
Bi-iliac breadth	272.33	3	8.62
Lower limb length	797.80	9	52.05
Stature (Fully)			
Body Mass (FHD)	64.87	10	6.26
FEMALES			
Cranial index	93.63	1	
Cranial module	146.17	2	1.65
Facial index	171.94	2	6.31
Nasal index	94.04	1	
Relative torso height	47.17	2	2.53
Brachial index	78.83	4	1.14
Crural index	85.19	3	1.95
Relative upper limb/ torso height	150.28	2	7.92
Interlimb index	69.99	3	1.39
Upper body width	277.56	1	
Bi-iliac breadth	251.00	2	1.41
Lower limb length	710.08	3	21.74
Stature (Fully)	145.35	1	
Body Mass (FHD)	51.73	4	3.17

AYALÁN

Dimension	Mean	N	Std. Dev.
MALES			
Cranial index	85.57	3	7.43
Cranial module	149.67	2	0.47
Facial index	190.45	1	
Nasal index	88.46	3	9.56
Relative torso height	47.24	4	2.19
Brachial index	80.14	3	1.37
Crural index	84.79	4	1.97
Relative upper limb/ torso height	146.83	3	4.63
Interlimb index	70.70	3	1.18
Upper body width			
Bi-iliac breadth	245.00	1	
Lower limb length	780.00	4	23.00
Stature (Fully)	161.46	1	
Body Mass (FHD)	62.43	4	3.38
FEMALES			
Cranial index	85.18	6	3.17
Cranial module	143.56	6	1.29
Facial index	176.64	2	11.36
Nasal index	87.16	2	3.27
Relative torso height	48.87	5	1.42
Brachial index	79.37	4	3.27
Crural index	86.26	5	1.99
Relative upper limb/ torso height	142.98	4	5.46
Interlimb index	69.96	4	0.96
Upper body width	307.90	1	
Bi-iliac breadth	243.17	3	12.29
Lower limb length	702.90	5	44.05
Stature (Fully)	148.32	4	5.18
Body Mass (FHD)	50.39	5	2.20

ANCÓN

Dimension	Mean	N	Std. Dev.
MALES			
Cranial index	78.16	1	
Cranial module	148.86	26	3.95
Facial index	174.05	25	12.58
Nasal index	74.89	25	6.25
Relative torso height	49.15	18	2.94
Brachial index	77.86	28	2.08
Crural index	85.58	28	1.89
Relative upper limb/ torso height	143.12	18	7.58
Interlimb index	70.04	28	1.28
Upper body width	323.02	20	12.33
Bi-iliac breadth	269.18	22	13.90
Lower limb length	762.54	28	33.07
Stature (Fully)	158.16	16	5.61
Body Mass (FHD)	68.02	28	6.39
FEMALES			
Cranial index	82.95	2	1.44
Cranial module	142.88	23	4.27
Facial index	170.45	23	9.66
Nasal index	79.60	23	7.55
Relative torso height	48.15	11	2.08
Brachial index	77.46	23	1.87
Crural index	86.48	23	1.72
Relative upper limb/ torso height	143.44	11	5.24
Interlimb index	69.02	23	0.98
Upper body width	283.49	12	13.84
Bi-iliac breadth	257.73	15	9.40
Lower limb length	701.88	23	34.09
Stature (Fully)	144.77	11	4.33
Body Mass (FHD)	56.28	23	5.27

ARAMBURU

Dimension	Mean	N	Std. Dev.
MALES			
Cranial index	81.61	2	2.43
Cranial module	149.78	3	2.77
Facial index	164.69	3	7.20
Nasal index	93.92	3	1.90
Relative torso height			
Brachial index	77.83	4	1.86
Crural index	85.14	3	3.69
Relative upper limb/ torso height			
Interlimb index	72.68	3	3.67
Upper body width			
Bi-iliac breadth	270.75	2	11.67
Lower limb length	739.92	3	39.55
Stature (Fully)			
Body Mass (FHD)	63.72	3	6.96
FEMALES			
Cranial index	82.42	1	
Cranial module	142.67	4	1.61
Facial index	167.42	4	1.98
Nasal index	97.07	4	7.22
Relative torso height			
Brachial index	74.22	2	0.94
Crural index	83.39	3	1.93
Relative upper limb/ torso height			
Interlimb index	73.55	2	2.13
Upper body width	292.63	1	
Bi-iliac breadth	241.00	1	
Lower limb length	672.25	3	13.18
Stature (Fully)			
Body Mass (FHD)	49.94	3	3.79

NASCA

Dimension	Mean	N	Std. Dev.
MALES			
Cranial index	83.43	1	
Cranial module	147.70	11	3.52
Facial index	172.34	10	11.05
Nasal index	104.03	11	3.57
Relative torso height			
Brachial index	78.56	7	1.30
Crural index	86.68	10	1.97
Relative upper limb/ torso height			
Interlimb index	70.39	7	1.35
Upper body width			
Bi-iliac breadth	274.38	4	26.20
Lower limb length	779.95	10	36.40
Stature (Fully)			
Body Mass (FHD)	65.60	10	4.77
FEMALES			
Cranial index	85.53	2	5.32
Cranial module	143.20	10	4.11
Facial index	169.16	8	10.65
Nasal index	105.66	9	6.79
Relative torso height	48.14	2	0.85
Brachial index	78.42	9	2.13
Crural index	86.79	9	1.41
Relative upper limb/ torso height	142.08	2	1.98
Interlimb index	69.81	9	1.49
Upper body width			
Bi-iliac breadth	264.88	4	23.64
Lower limb length	715.39	9	44.38
Stature (Fully)	146.84	1	
Body Mass (FHD)	54.30	9	6.15

CERRO AZUL & CERRO DEL ORO

Dimension	Mean	N	Std. Dev.
MALES			
Cranial index	82.91	2	1.62
Cranial module	148.67	7	2.60
Facial index	171.52	7	11.96
Nasal index	98.24	7	2.33
Relative torso height			
Brachial index	77.93	5	5.63
Crural index	84.26	7	1.89
Relative upper limb/ torso height			
Interlimb index	68.09	5	2.84
Upper body width			
Bi-iliac breadth			
Lower limb length	743.89	7	36.40
Stature (Fully)			
Body Mass (FHD)	63.47	7	3.43
FEMALES			
Cranial index			
Cranial module	144.33	7	3.67
Facial index	167.86	7	8.92
Nasal index	98.07	7	2.89
Relative torso height			
Brachial index	81.34	2	0.12
Crural index	84.80	7	2.19
Relative upper limb/ torso height			
Interlimb index	69.70	2	0.36
Upper body width			
Bi-iliac breadth			
Lower limb length	695.96	7	17.09
Stature (Fully)			
Body Mass (FHD)	53.69	7	4.08

Appendix V. Part C. Derived morphology for the early Holocene specimens (10000-8000 yBP), by region.

Southeastern U.S. (Region 5): cranial morphology

MALES

Site		Cranial Index	Cranial Module	Facial Index	Nasal Index
Warm Mineral Springs	Mean	71.35	152.67	186.93	
	N	2	1	2	
	Std. Deviation	.23		10.94	
	Range	.32	.00	15.47	
Windover Pond	Mean	73.94	152.00	173.11	89.54
	N	37.00	36.00	27.00	27.00
	Std. Deviation	3.26	3.01	10.11	8.28
	Range	13.64	11.67	37.69	48.20
Total	Mean	73.81	152.02	174.06	89.54
	N	39.00	37.00	29.00	27.00
	Std. Deviation	3.23	2.97	10.58	8.28
	Range	13.64	11.67	39.45	48.20

FEMALES

Site		Cranial Index	Cranial Module	Facial Index	Nasal Index
Little Salt Spring	“Mean”	82.68	155.33	182.71	82.36
	N	1	1	1	1
	Std. Deviation				
	Range	.00	.00	.00	.00
Warm Mineral Springs	“Mean”	74.42	139.00	163.77	92.49
	N	1	1	1	1
	Std. Deviation				
	Range	.00	.00	.00	.00
Windover Pond	Mean	74.45	146.01	175.87	89.91
	N	30	29	22	22
	Std. Deviation	2.38	4.48	9.58	6.06
	Range	9.78	19.67	31.16	22.41
Total	Mean	74.71	146.09	175.65	89.70
	N	32	31	24	24
	Std. Deviation	2.72	4.82	9.60	6.02
	Range	11.99	19.67	31.16	22.41

Great Basin (Region 6): cranial morphology

MALE

Site		Cranial Index	Cranial Module	Facial Index	Nasal Index
Spirit Cave	“Mean”	71.65	157.00	174.62	80.07
	N	1	1	1	1
	Std. Deviation				
	Range	.00	.00	.00	.00

Western Plateau (Region 9): cranial morphology

MALE

Site		Cranial Index	Cranial Module	Facial Index
Kennewick	“Mean”	74.82	156.89	143.44
	N	1	1	1
	Std. Deviation			
	Range	.00	.00	.00

Southern Texas (Region 11): cranial morphology

MALE

Site		Cranial Index	Cranial Module	Facial Index	Nasal Index
Horn Shelter	“Mean”	74.33	153.33	172.25	83.95
	N	1	1	1	1
	Std. Deviation				
	Range	.00	.00	.00	.00

FEMALE

Site		Cranial Index	Cranial Module
Scharbauer Site	“Mean”	69.61	146.00
	N	1	1
	Std. Deviation		
	Range	.00	.00

Southeastern U.S. (Region 5): postcranial proportions

MALES

Site		Relative Torso Height	Brachial Index	Crural Index	Upper Limb Length/Torso Height	Interlimb Index
Warm Mineral Springs	“Mean”		77.42			
	N		1			
	Std. Deviation					
	Range		.00			
Windover Pond	Mean	44.74	79.47	85.50	153.37	68.73
	N	13	32	28	14	23
	Std. Deviation	1.75	1.69	1.91	6.60	1.14
	Range	5.50	6.55	8.82	23.95	4.10
Total	Mean	44.74	79.41	85.50	153.37	68.73
	N	13	33	28	14	23
	Std. Deviation	1.75	1.70	1.91	6.60	1.14
	Range	5.50	6.55	8.82	23.95	4.10

FEMALES

Site		Relative Torso Height	Brachial Index	Crural Index	Upper Limb Length/Torso Height	Interlimb Index
Warm Mineral Springs	“Mean”		75.34			
	N		1			
	Std. Deviation					
	Range		.00			
Windover Pond	Mean	45.29	77.59	85.23	150.40	68.55
	N	7	21	18	7	17
	Std. Deviation	2.56	2.77	2.52	10.54	1.48
	Range	7.65	11.18	10.99	31.40	6.47
Total	Mean	45.29	77.49	85.23	150.40	68.55
	N	7	22	18	7	17
	Std. Deviation	2.56	2.75	2.52	10.54	1.48
	Range	7.65	11.18	10.99	31.40	6.47

Great Basin (Region 6): postcranial proportions

MALES

Site		Relative Torso Height	Brachial Index	Crural Index	Upper Limb Length/Torso Height	Interlimb Index
Spirit Cave	“Mean”	49.33	79.33	82.92	139.82	68.97
	N	1	1	1	1	1
	Std. Deviation					
	Range	.00	.00	.00	.00	.00
Wizard's Beach	“Mean”		76.99	86.22		70.34
	N		1	1		1
	Std. Deviation					
	Range		.00	.00		.00
Total	Mean	49.33	78.16	84.57	139.82	69.66
	N	1	2	2	1	2
	Std. Deviation		1.65	2.33		.97
	Range	.00	2.34	3.30	.00	1.37

Western Plateau (Region 9): postcranial proportions

MALES

Site		Relative Torso Height	Brachial Index	Crural Index	Upper Limb Length/Torso Height	Interlimb Index
Kennewick	“Mean”	45.04	75.94	86.16	155.03	69.83
	N	1	1	1	1	1
	Std. Deviation					
	Range	.00	.00	.00	.00	.00
Gore Creek	“Mean”			84.47		
	N			1		
	Std. Deviation					
	Range			.00		
Total	Mean	45.04	75.94	85.32	155.03	69.83
	N	1	1	2	1	1
	Std. Deviation			1.20		
	Range	.00	.00	1.69	.00	.00

Southern Texas (Region 11): postcranial proportions

MALE

Site		Brachial Index	Crural Index	Interlimb Index
Horn Shelter	“Mean”	79.06	83.68	71.85
	N	1	1	1
	Std. Deviation			
	Range	.00	.00	.00

FEMALE

Site		Brachial Index
Wilson-Leonard	“Mean”	78.26
	N	1
	Std. Deviation	
	Range	.00

Brazil (Region 17): postcranial proportions

FEMALE

Site		Brachial Index	Crural Index	Interlimb Index
Sao Raimundo	“Mean”	78.31	86.96	68.87
	N	1	1	1
	Std. Deviation			
	Range	.00	.00	.00

Great Plains (Region 3): postcranial morphologies

FEMALE

Site		Body Mass
Gordon Creek	“Mean”	58.76
	N	1
	Std. Deviation	
	Range	.00

Southeastern U.S. (Region 5): postcranial morphologies

MALES

Site		Upper Body Width	Bi-iliac Breadth	Lower Limb Length	Stature	Body Mass
Warm Mineral Springs	Mean		278.00			68.18
	N		1			3
	Std. Deviation					2.66
	Range		.00			5.17
Windover Pond	Mean	327.12	265.42	819.92	166.32	65.00
	N	7	19	28	11	38
	Std. Deviation	14.21	10.93	33.99	4.77	5.40
	Range	41.74	38.00	135.75	13.75	23.53
Total	Mean	327.12	266.05	819.92	166.32	65.23
	N	7	20	28	11	41
	Std. Deviation	14.21	11.01	33.99	4.77	5.30
	Range	41.74	38.00	135.75	13.75	23.53

FEMALES

Site		Upper Body Width	Bi-iliac Breadth	Lower Limb Length	Stature	Body Mass
Windover Pond	Mean	289.77	250.94	760.59	154.77	54.49
	N	6	8	18	6	21
	Std. Deviation	11.26	17.77	35.38	3.00	4.62
	Range	32.09	62.00	113.75	8.17	17.50

Great Basin (Region 6): postcranial morphologies

MALES

Site		Upper Body Width	Bi-iliac Breadth	Lower Limb Length	Stature	Body Mass
Spirit Cave	“Mean”	321.79	279.00	773.50	160.84	61.63
	N	1	1	1	1	1
	Std. Deviation					
	Range	.00	.00	.00	.00	.00
Wizard's Beach	“Mean”			853.00		76.90
	N			1		1
	Std. Deviation					
	Range			.00		.00
Total	Mean	321.79	279.00	813.25	160.84	69.26
	N	1	1	2	1	2
	Std. Deviation			56.21		10.80
	Range	.00	.00	79.50	.00	15.27

Western Plateau (Region 9): postcranial morphologies

MALES

Site		Bi-iliac Breadth	Lower Limb Length	Stature	Body Mass
Kennewick	“Mean”	281.00	858.50	171.74	73.66
	N	1	1	1	1
	Std. Deviation				
	Range	.00	.00	.00	.00
Gore Creek	“Mean”		829.24		
	N		1		
	Std. Deviation				
	Range		.00		
Total	Mean	281.00	843.87	171.74	73.66
	N	1	2	1	1
	Std. Deviation	.	20.69	.	.
	Range	.00	29.26	.00	.00

Southern Texas (Region 11): postcranial morphologies

MALE

Site		Lower Limb Length	Body Mass
Horn Shelter	“Mean”	785.61	69.14
	N	1	1
	Std. Deviation		
	Range	.00	.00

FEMALE

Site		Body Mass
Wilson-Leonard	“Mean”	63.48
	N	1
	Std. Deviation	
	Range	.00

Brazil (Region 17): postcranial proportions

FEMALE

Site		Lower Limb Length	Body Mass
Sao Raimundo	“Mean”	733.97	50.82
	N	1	1
	Std. Deviation		
	Range	.00	.00

Appendix VI. Results – derived morphologies across geography & time, POD and EOD

The following pages present the distribution of seven derived morphologies across geography and through time: nasal index, brachial index, crural index, relative torso height (RTH), bi-iliac breadth (BIB), stature, and body mass. These are shown by site means (see Appendix V for values), represented by colored dots on maps of the Americas at the latitude and longitude of sites. Note that these represent sample means, and in some cases the available data for a given morphology is limited to members of one sex from a sample; some dots appear to be incongruent between male and female maps for this reason. (In the case of a site with a number of locations—namely the Aleutian Islands—the dots are placed at the mean latitude and longitude for the sites.) Dot colors reflect fifth percentiles (i.e., 0-20%, 20-40%, 40-60%; see Table A6) of the range of each morphology in the complete available sample (POD, EOD, and COD), though only sites from the POD and EOD are displayed. The use of Old World samples in determining these groupings was chosen so that variation in the Americas is presented in the context of a global range of variation in human morphology. For example, although there is variation in bi-iliac breadth across the Americas, none of the American samples have bi-iliac breadths as low as those in African samples of the COD (see section 6.7). Time periods are the same as those used in analyses in section 6.3.

In all cases, fifth percentiles are shown in five colors: dark red, orange, brown, green, and dark blue. Colors trending toward the blues represent percentiles hypothetically found in cooler climates. For example, wide bi-iliac breadths (the highest fifth percentile) are dark blue, and narrow bi-iliac breadths (the lowest fifth percentile) are dark red. Body mass and relative torso height are also coded in this manner. In contrast, low intralimb indices (the lowest fifth percentile) are dark blue, and the highest intralimb indices (the highest fifth

percentile) are dark red. This pattern is also employed for nasal indices. Stature, though it is not hypothesized to covary with climate, is coded using the latter system.

Climate variables (MAT, MXT, MNT, and MTP) that significantly ($p < 0.05$) covary—determined from MANOVA results—with morphologies are designated as well on each figure. Pearson’s correlation coefficients (r -values) are provided for only significant correlations between climatic factors and morphologies. These are color-coded for analyses with and without high latitude samples: blue, analyses including high latitude samples; red, analysis excluding high latitude samples.

Table A6.1. Cutoffs for derived male morphology percentiles

Percentile ¹	Derived morphology ²						
	Nasal index	Brachial index	Crural index	RTH	BIB (cm)	Body Mass (kg)	Stature (cm)
20%	81.35%	76.89%	83.34%	45.70%	262.73	62.25	158.62
40%	84.66	77.63	84.45	46.98	268.83	64.97	160.74
60%	88.79	78.46	85.07	47.62	273.42	67.65	164.51
80%	92.37	79.28	85.63	48.74	278.10	70.10	167.90

¹ Based on all available samples in the POD, EOD and COD.

² See Appendix III for details concerning derived morphologies. Line colors correspond to dot colors in the figures, used to designate percentile groups.

Table A6.2. Cutoffs for derived female morphology percentiles

Percentile ¹	Derived morphology ²						
	Nasal index	Brachial index	Crural index	RTH	BIB (cm)	Body Mass (kg)	Stature (cm)
20%	84.97%	75.18%	82.97%	46.41%	254.29	51.89	147.83
40%	88.71	76.24	83.93	47.34	259.29	54.79	151.01
60%	91.61	77.25	84.53	47.93	264.00	56.90	155.34
80%	94.63	78.31	85.28	49.76	268.21	59.34	157.54

¹ Based on all available samples in the POD, EOD and COD.

² See Appendix III for details concerning derived morphologies. Line colors correspond to dot colors in the figures used to designate percentile groups.

Figure A6.1.1. Nasal index, all time periods, all samples

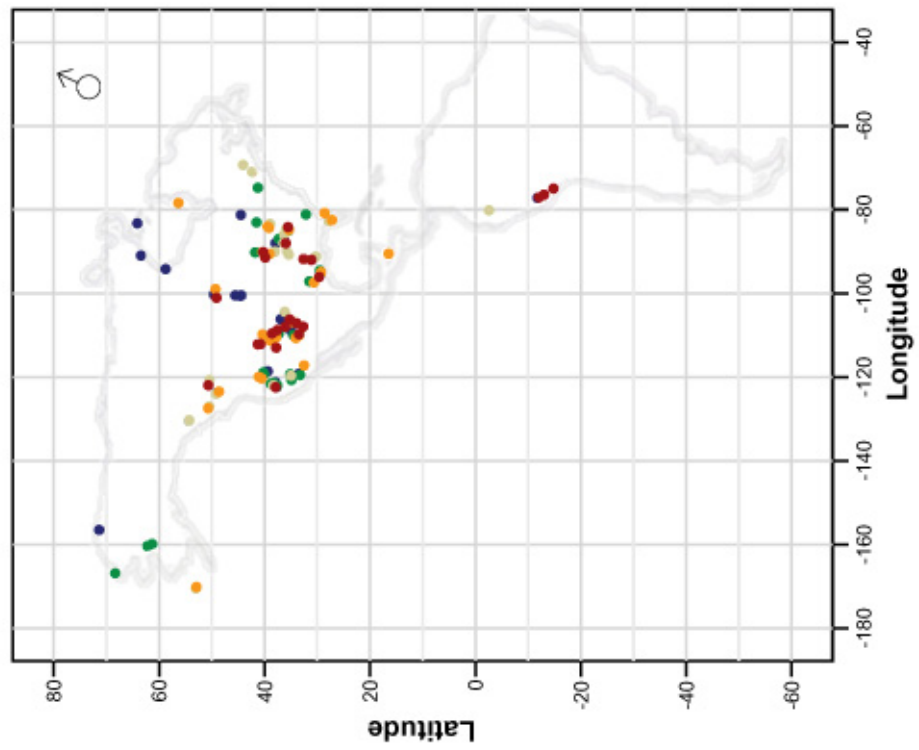
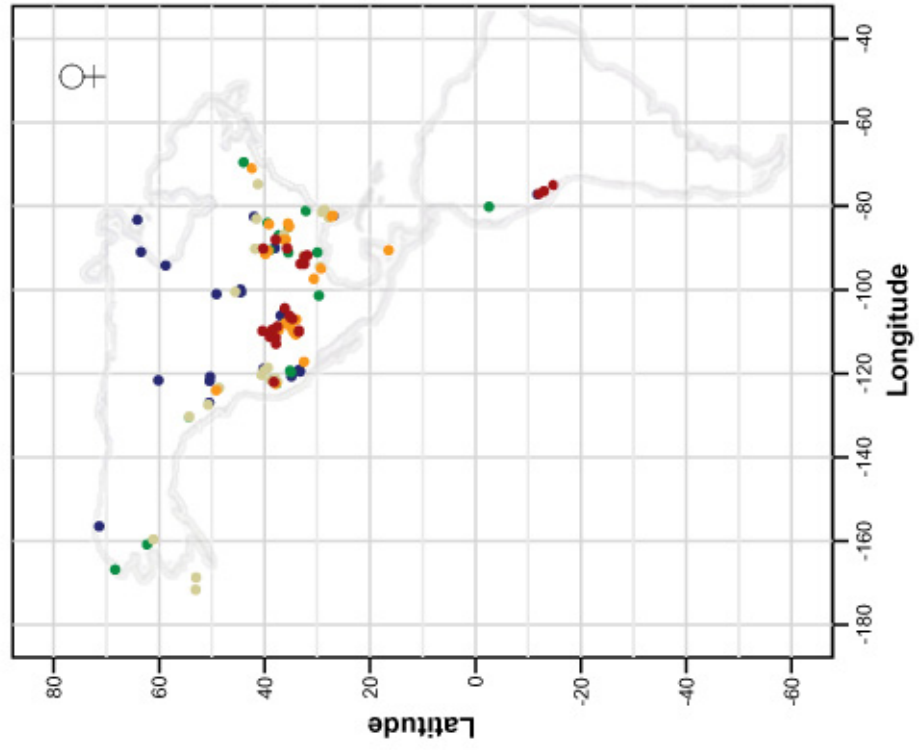


Figure A6.1.2. Male nasal index

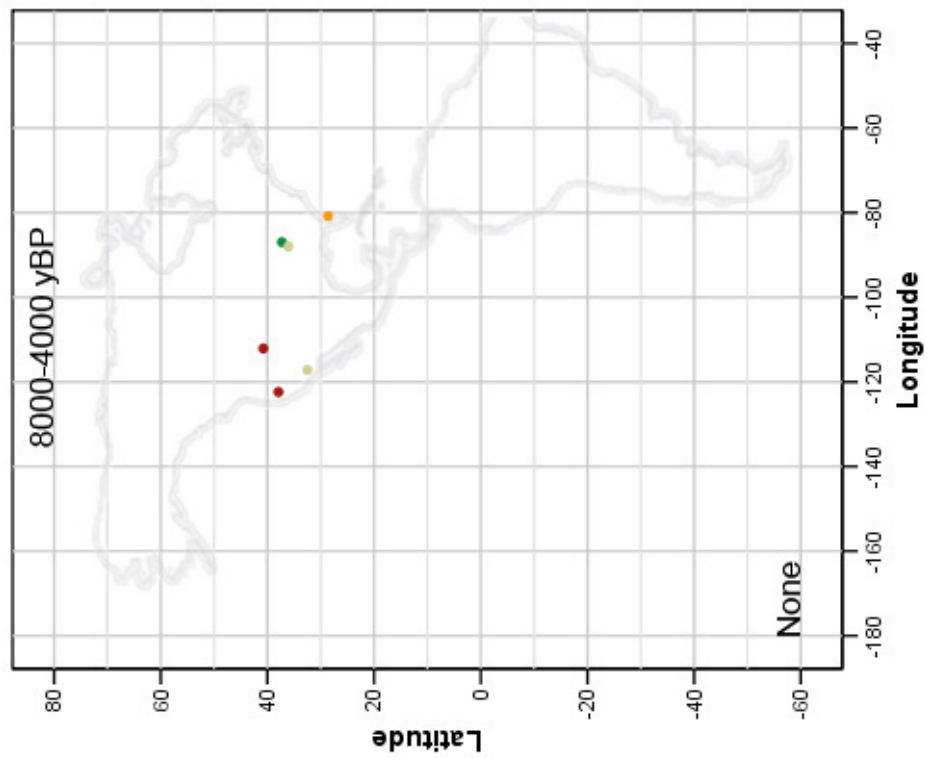
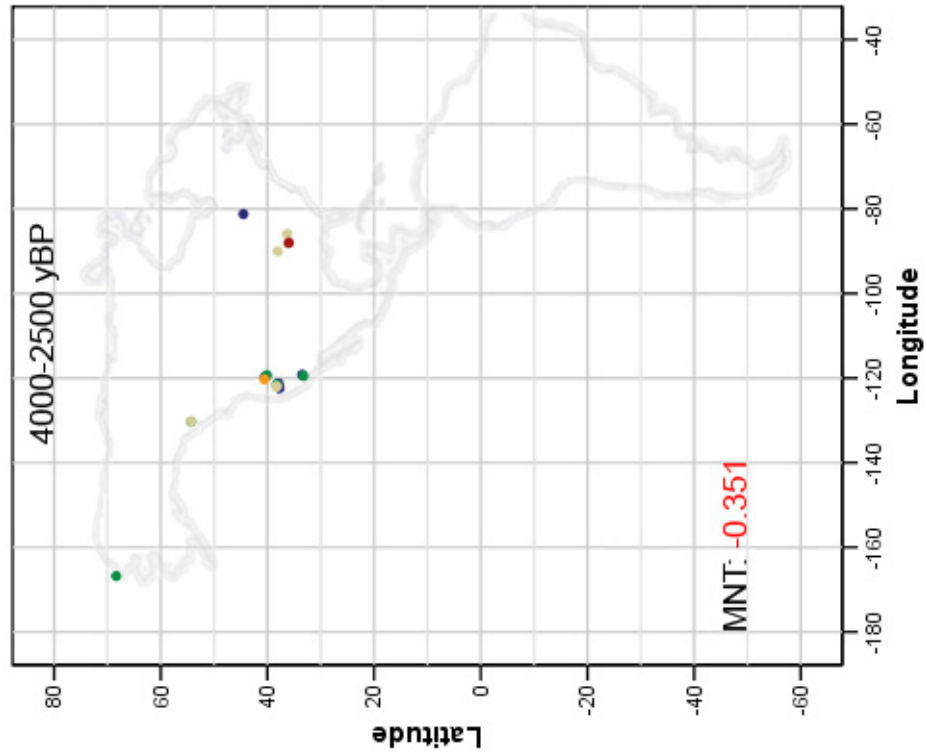


Figure A6.1.3. Male nasal index

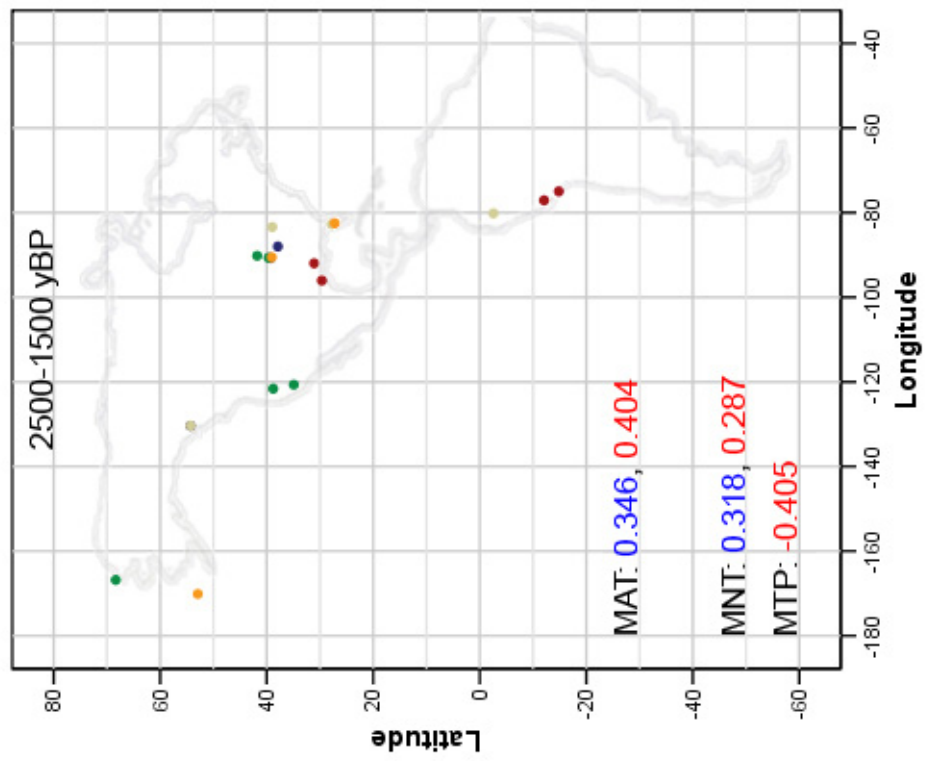
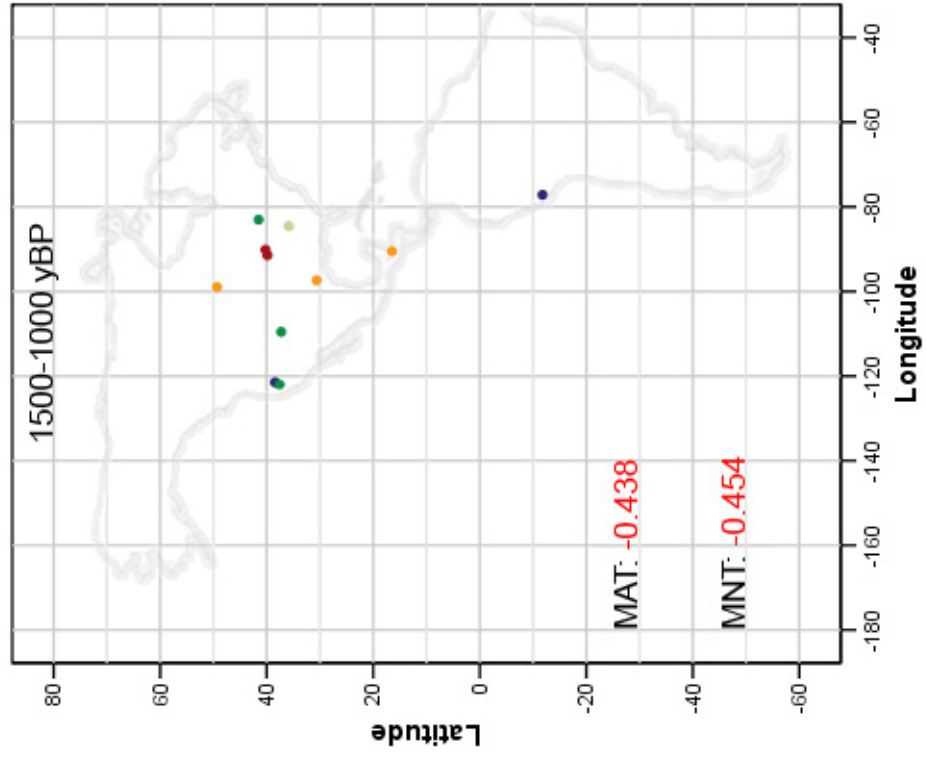


Figure A6.1.4. Male nasal index

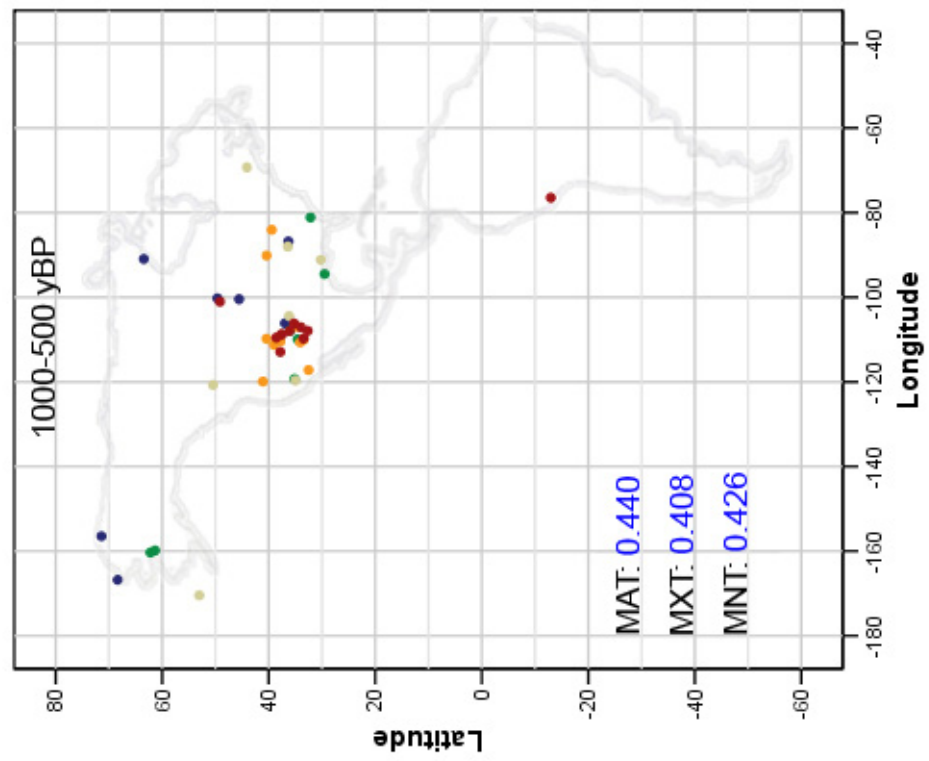
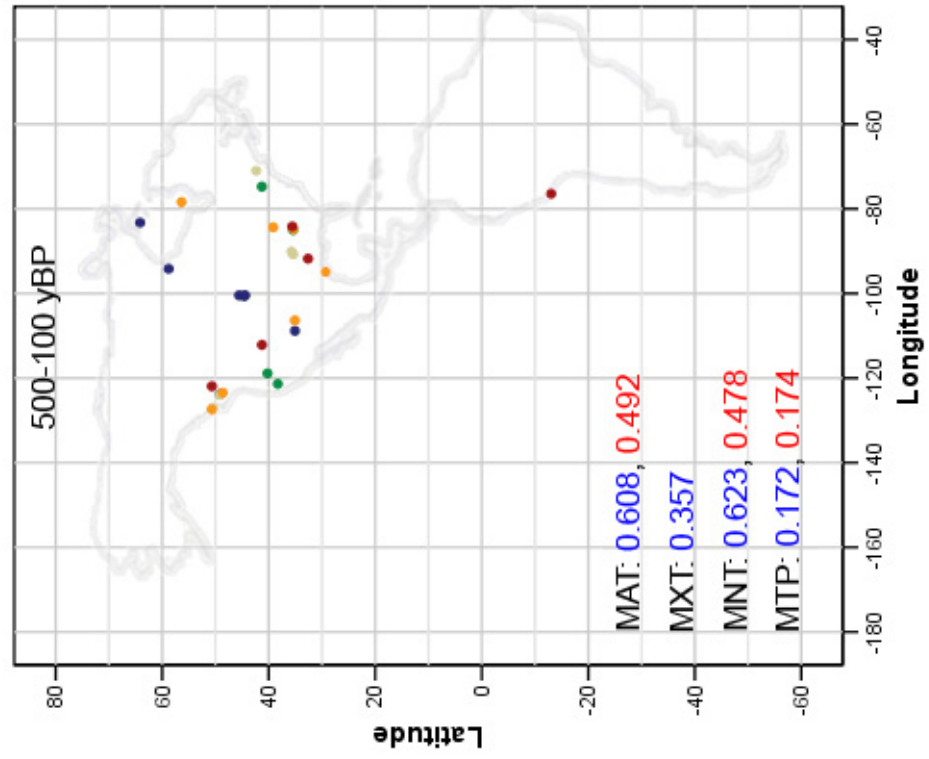


Figure A6.1.5. Female nasal index

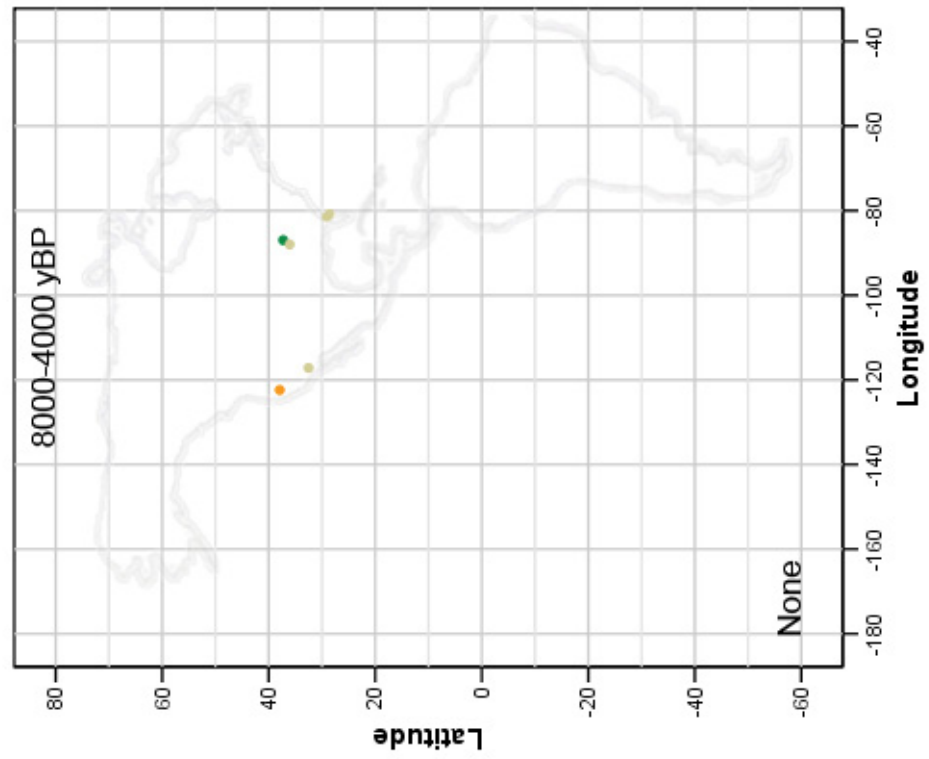
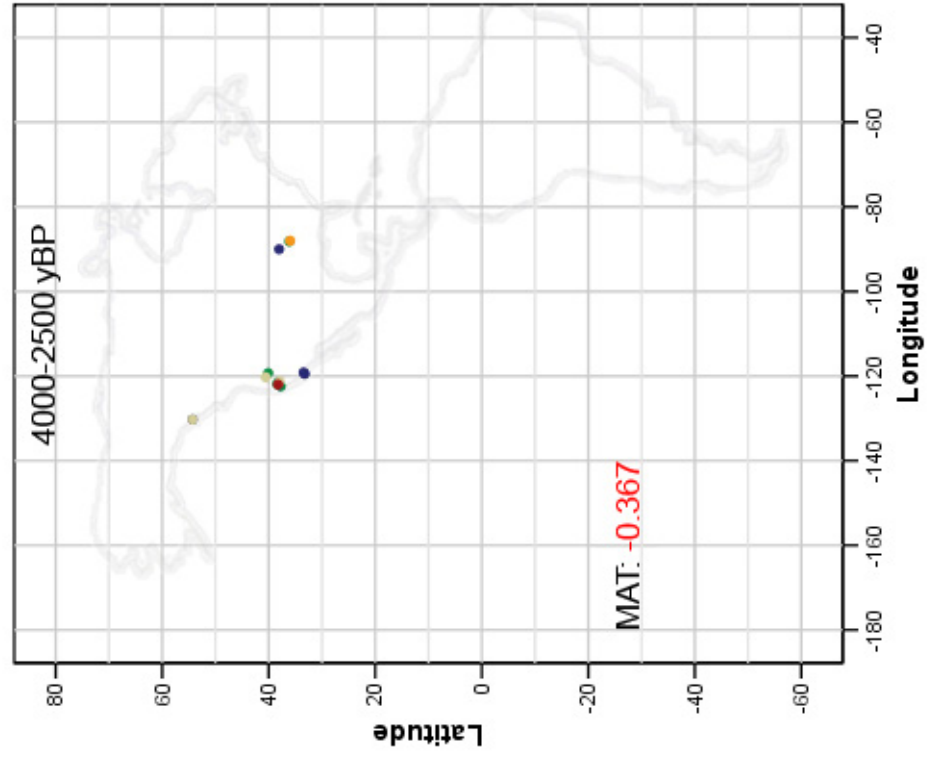


Figure A6.1.6. Female nasal index

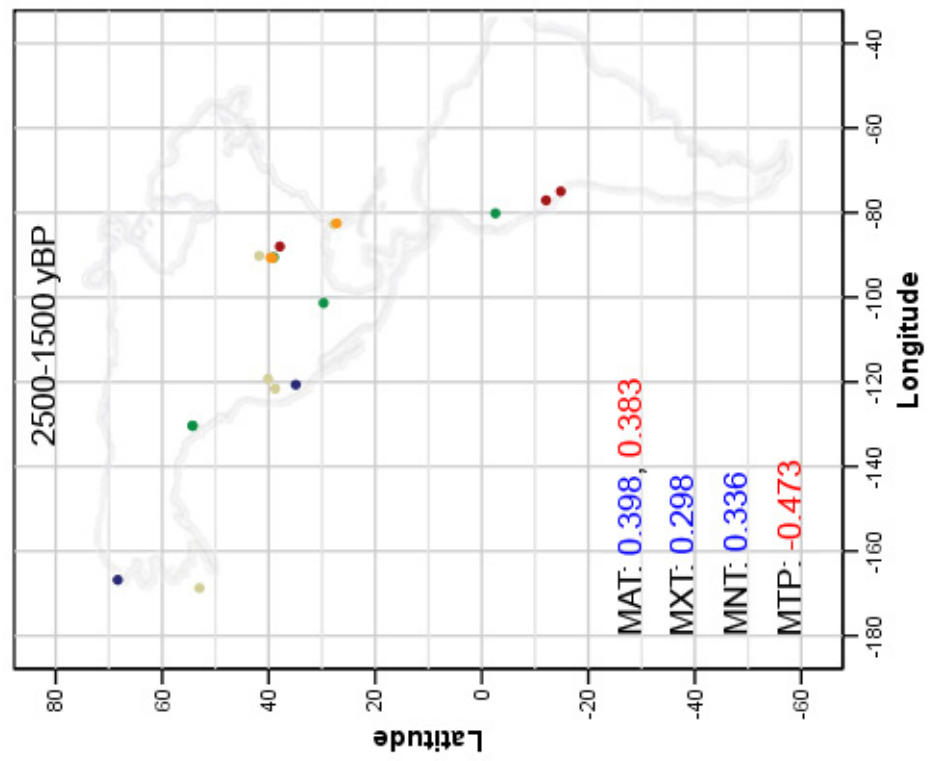
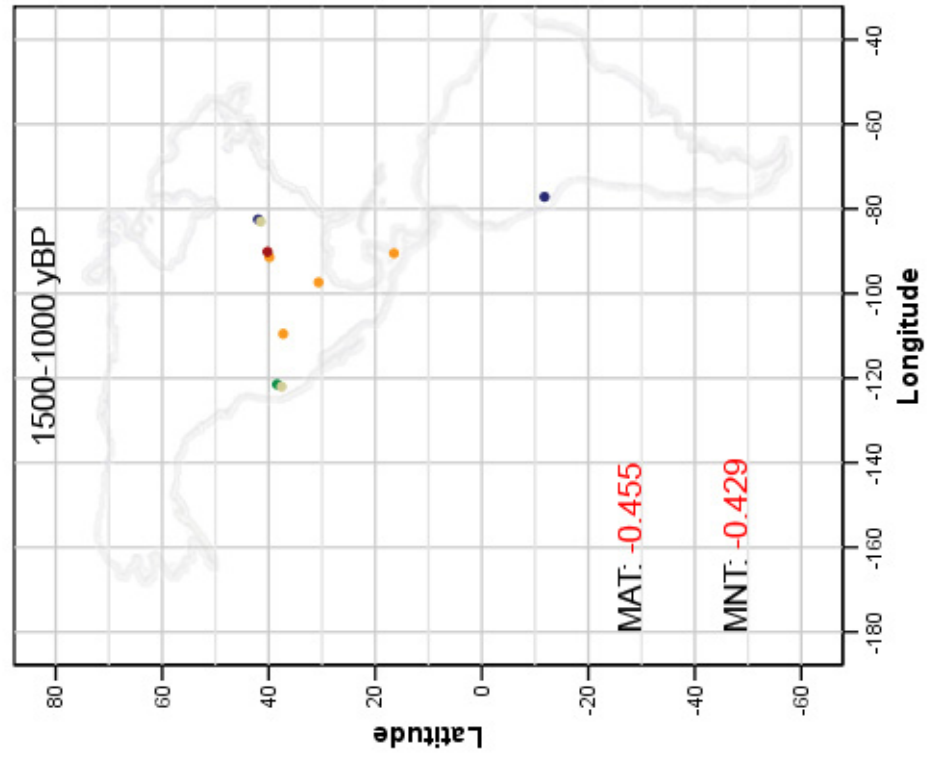


Figure A6.1.7. Female nasal index

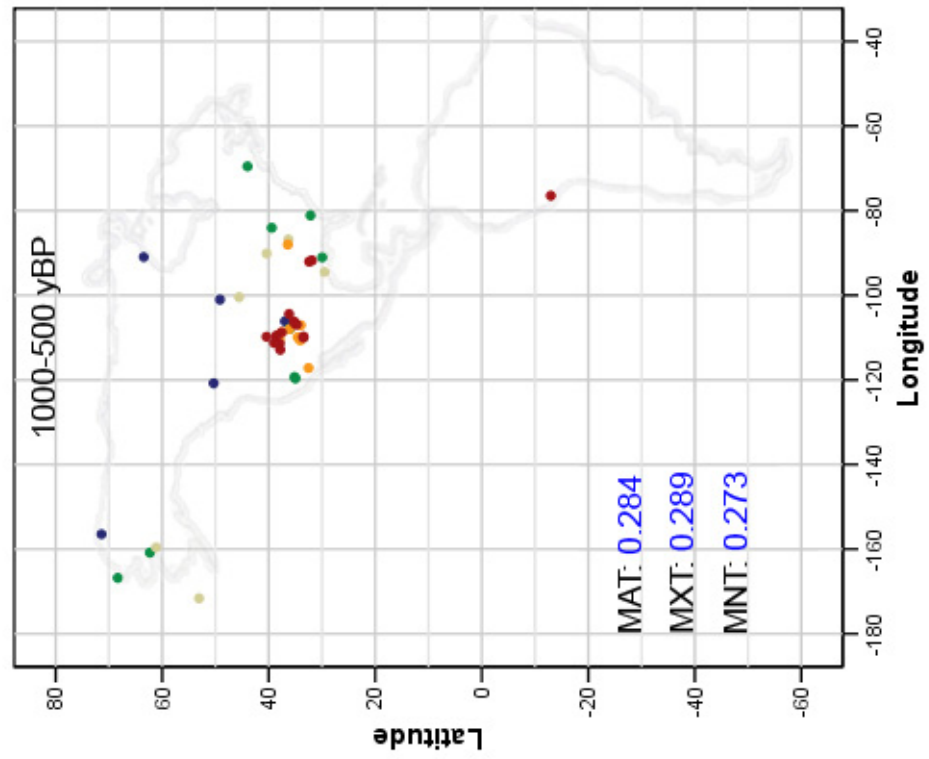
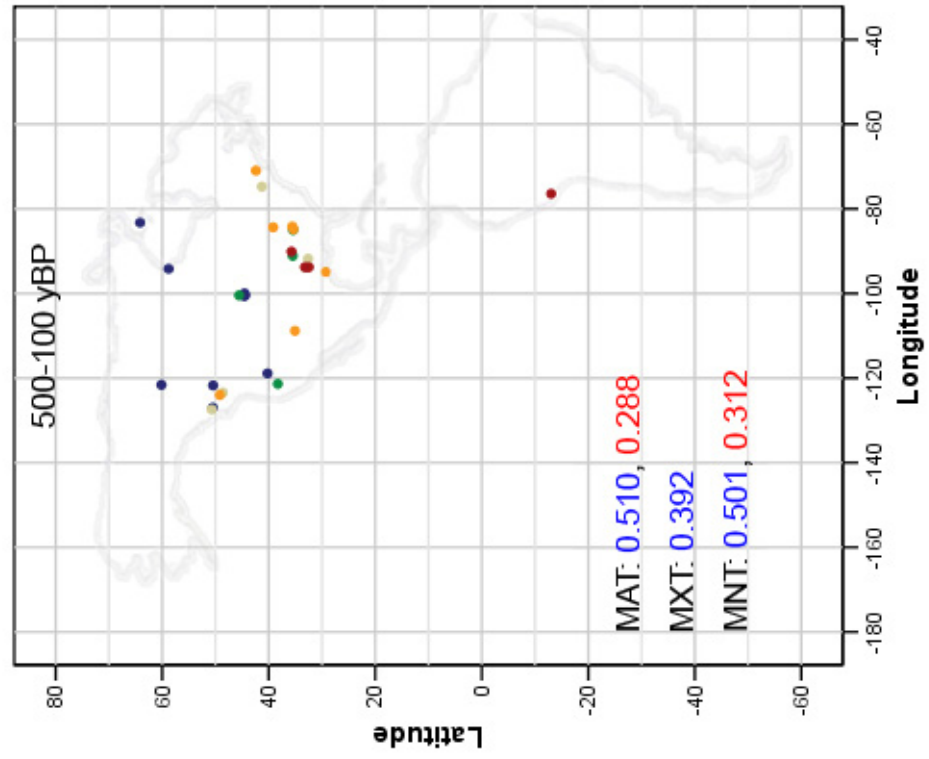


Figure A6.2.1. Brachial index, all time periods, all samples

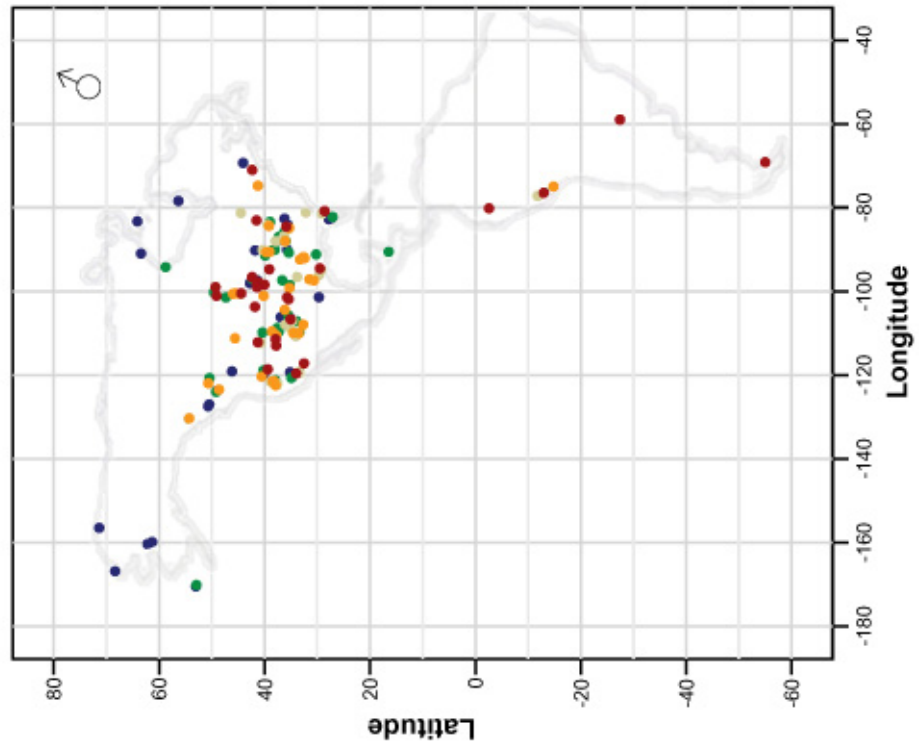
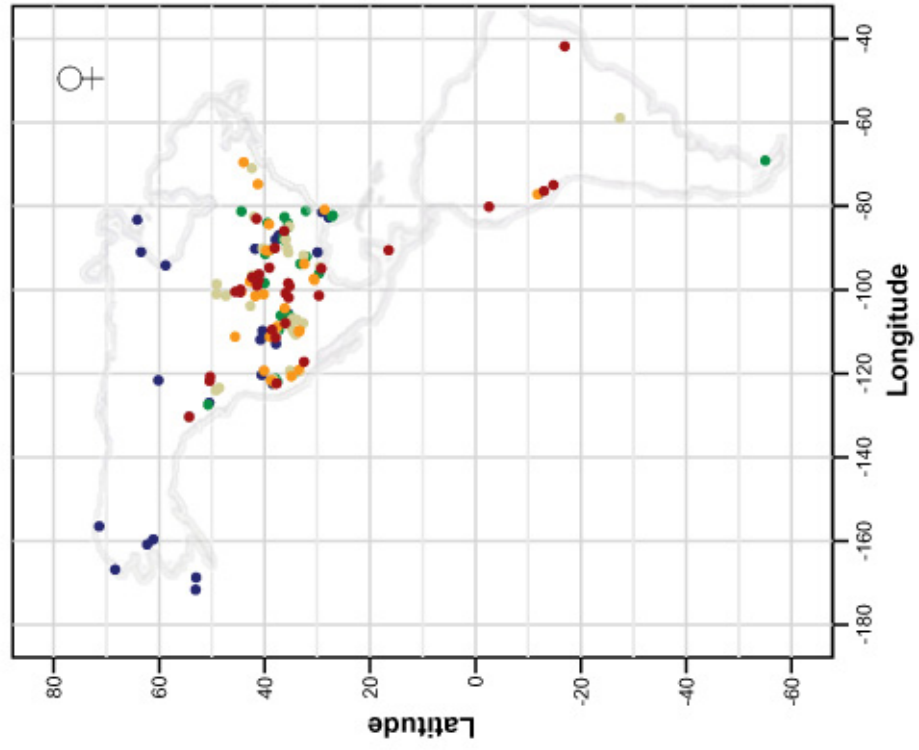


Figure A6.2.2. Male brachial index

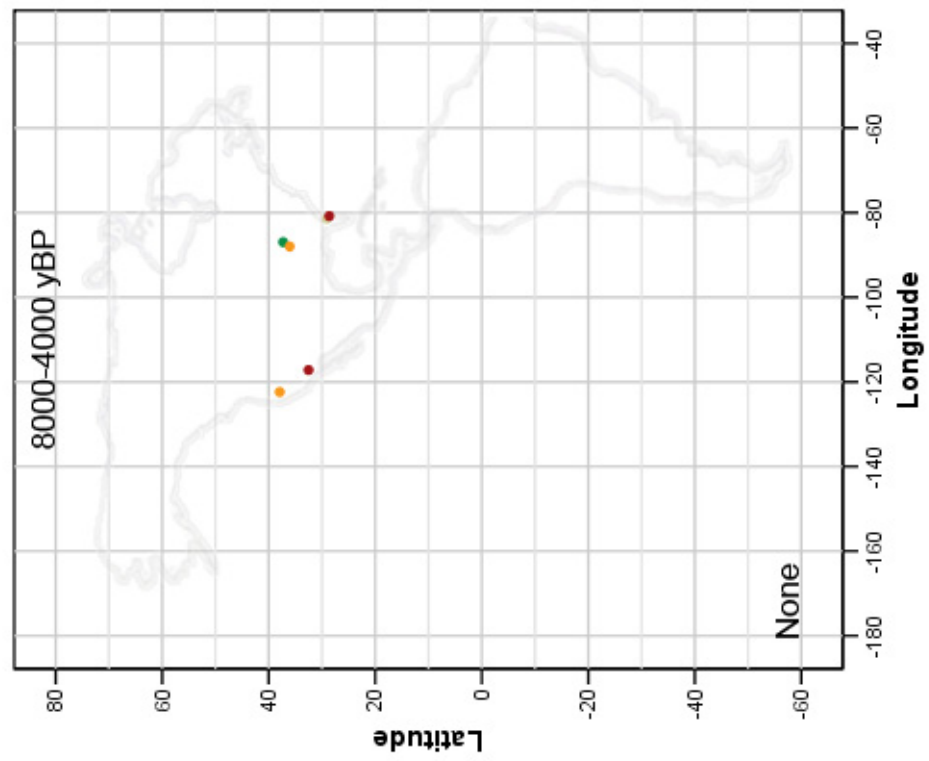
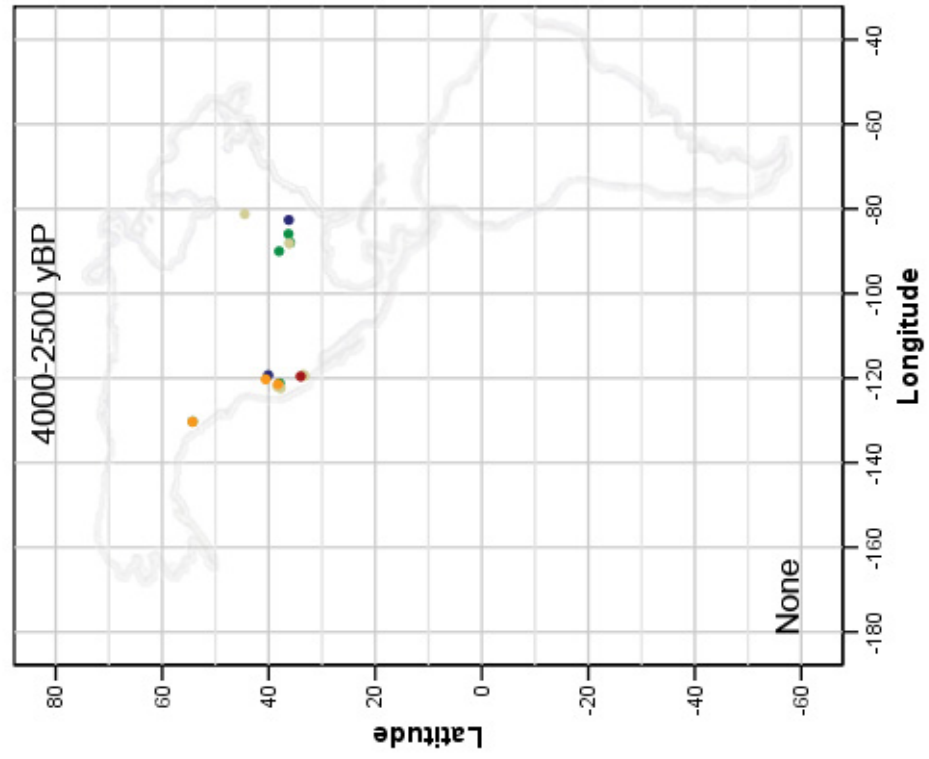


Figure A6.2.3. Male brachial index

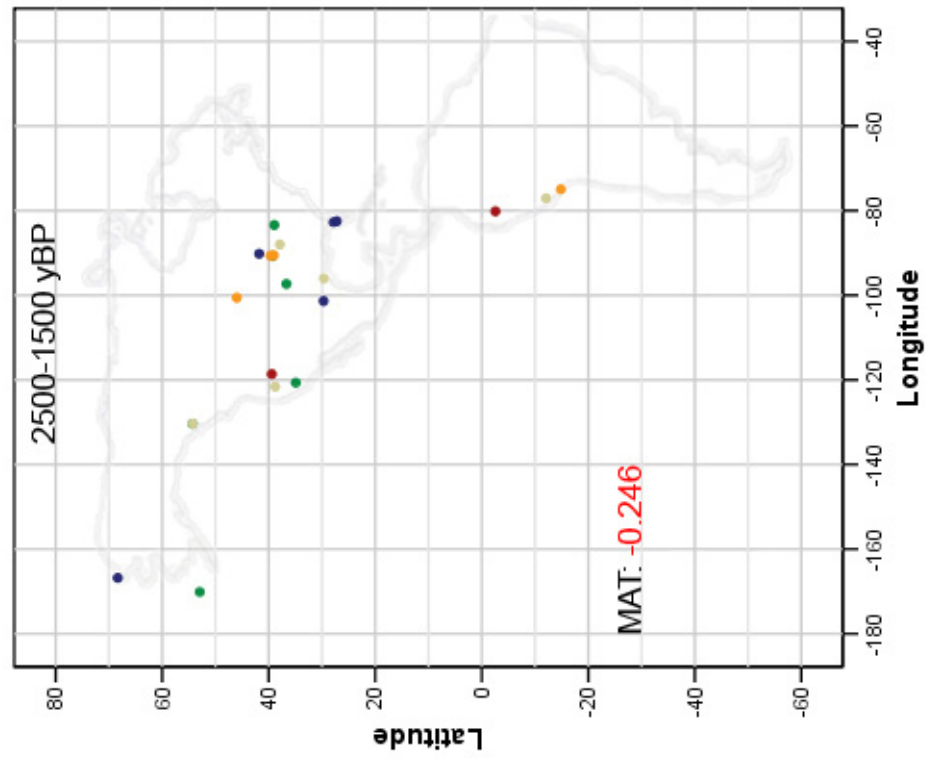
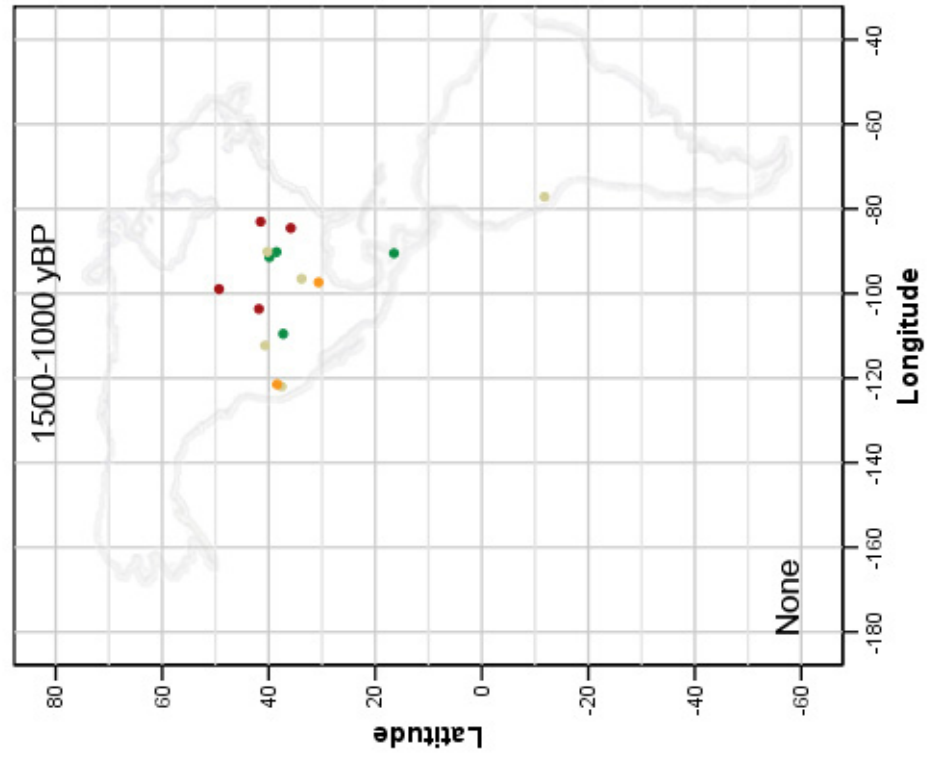


Figure A6.2.4. Male brachial index

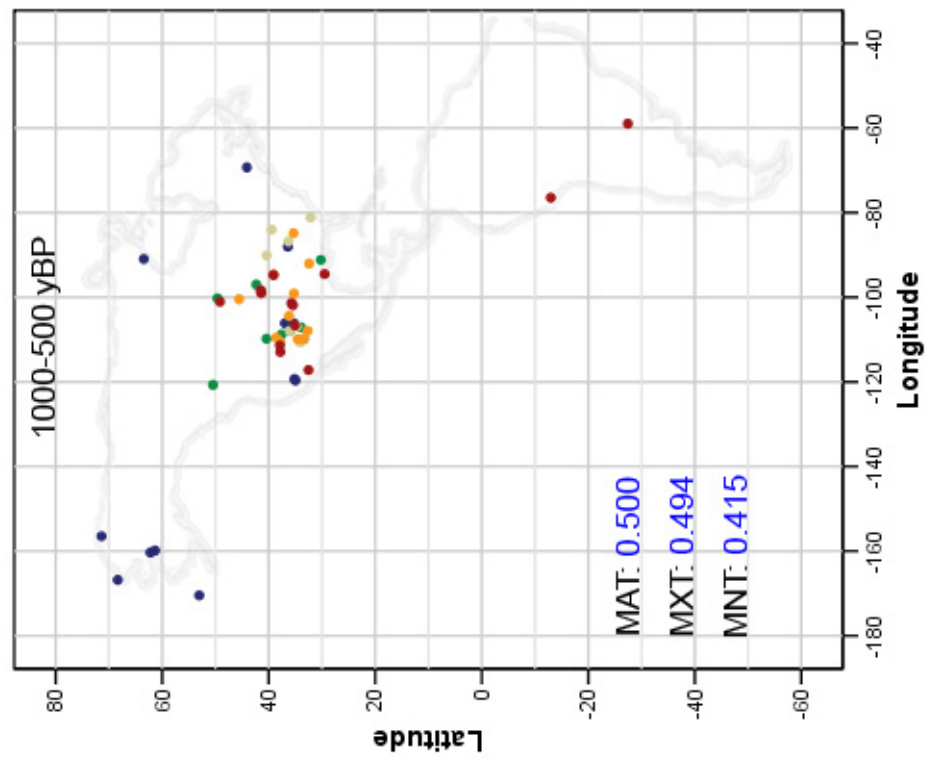
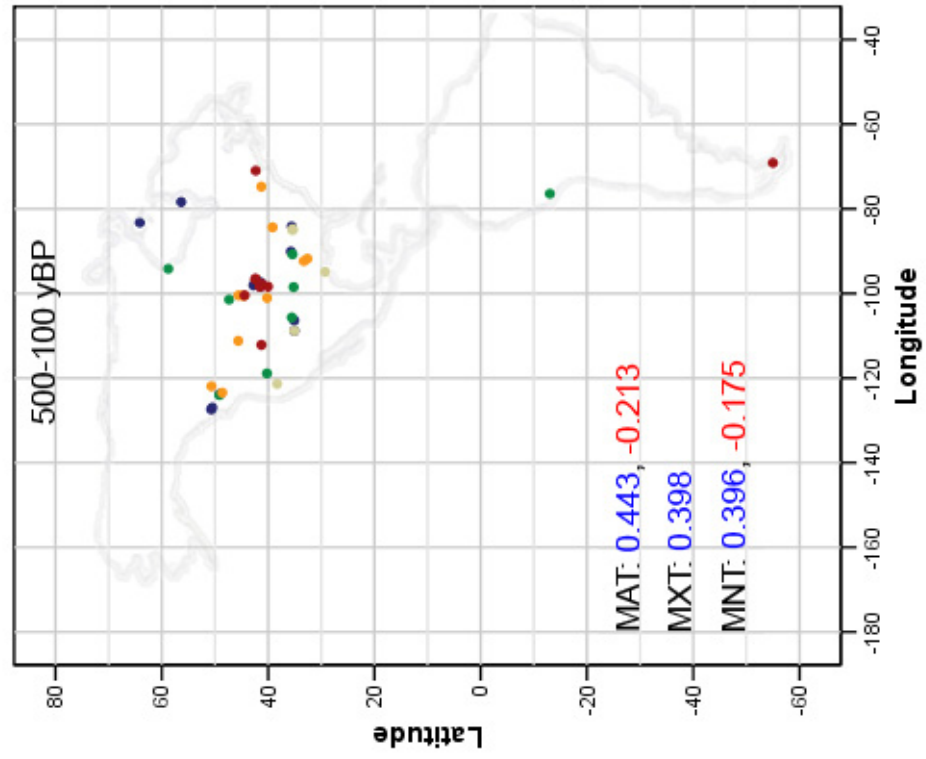


Figure A6.2.5. Female brachial index

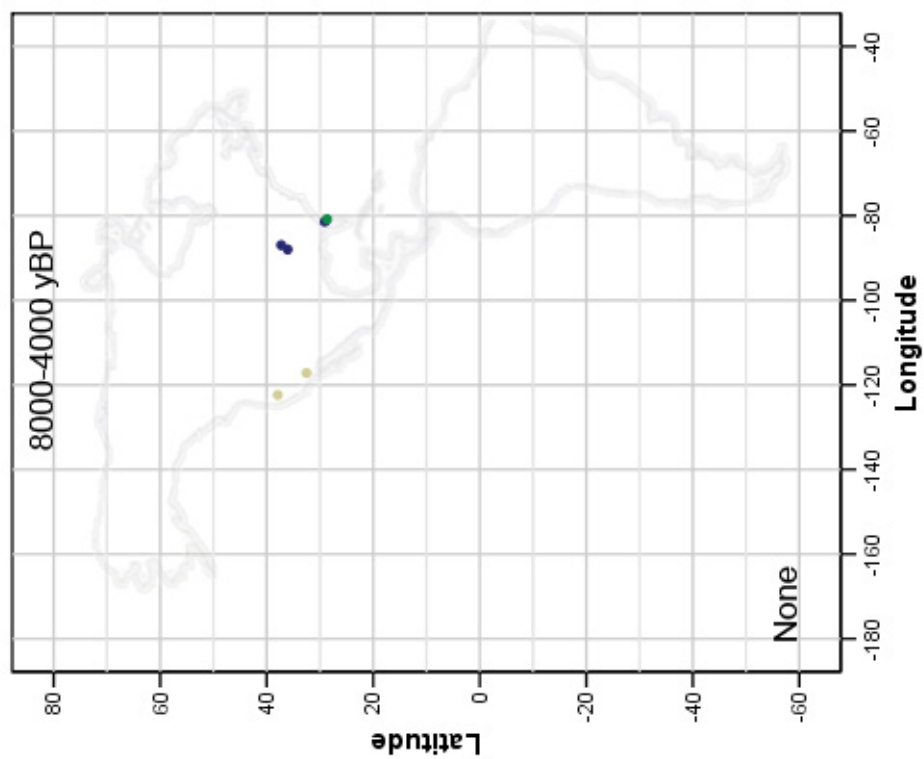
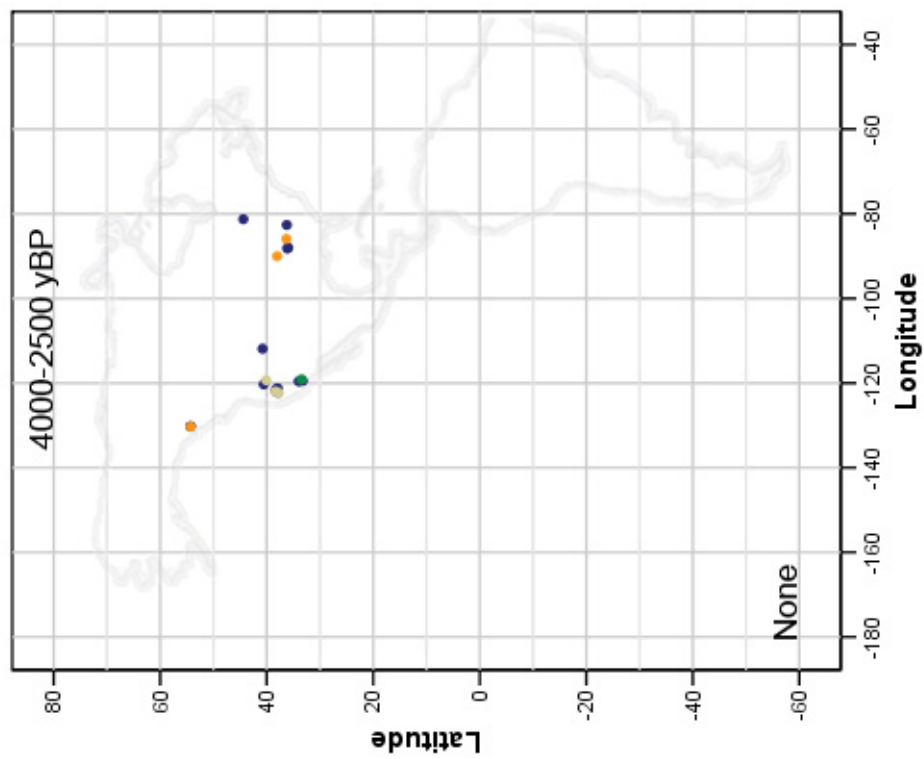


Figure A6.2.6. Female brachial index

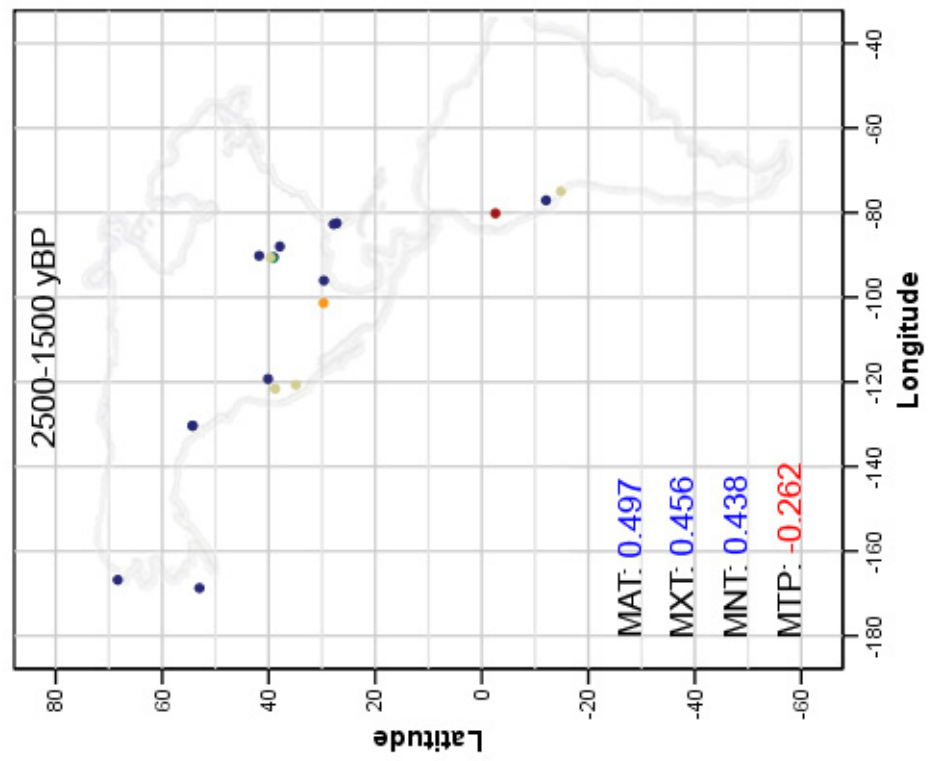
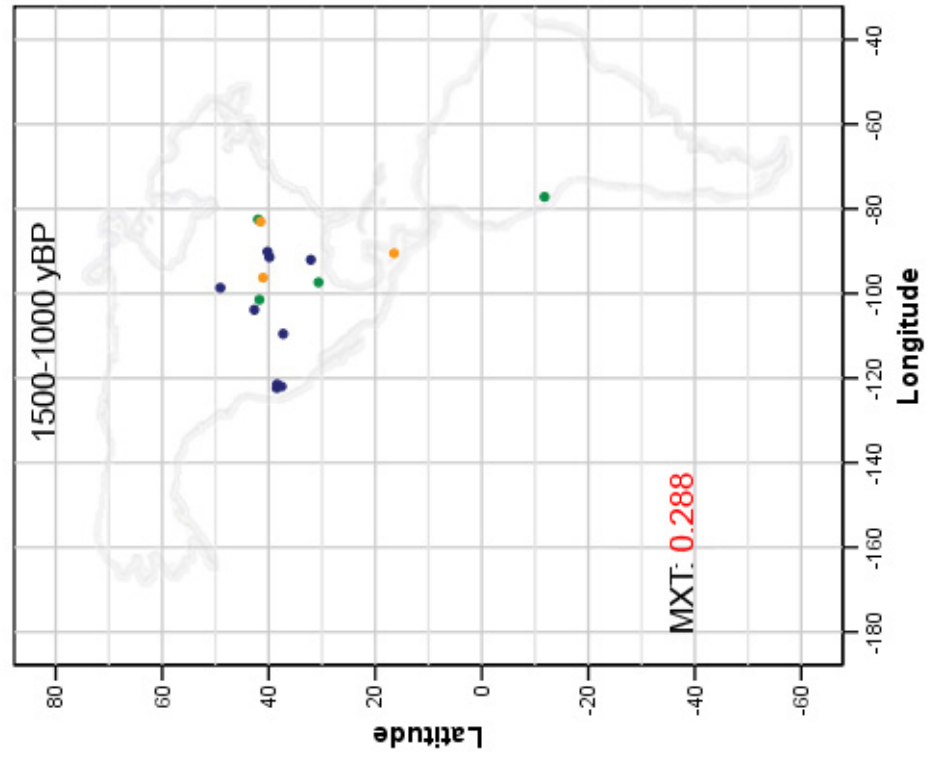


Figure A6.2.7. Female brachial index

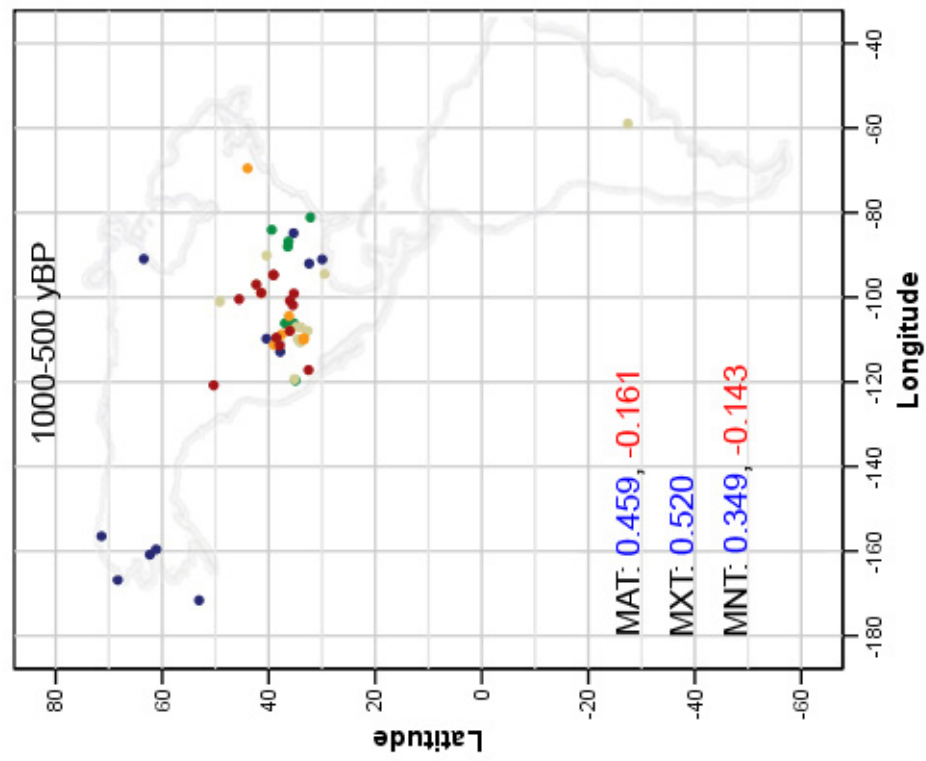
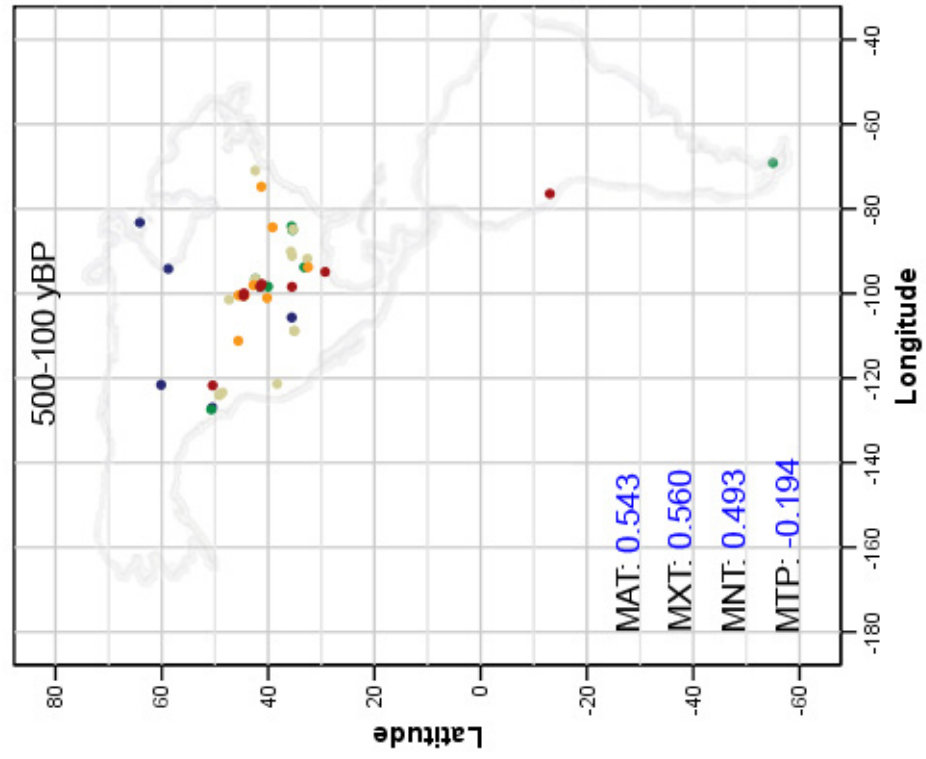


Figure A6.3.1.1. Crural index, all time periods, all samples

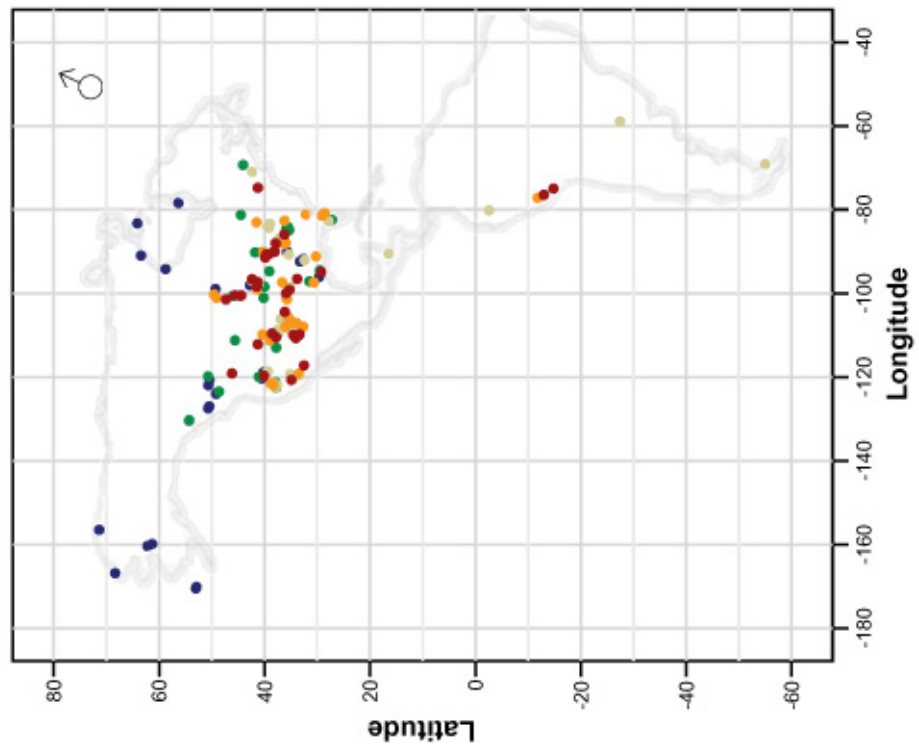
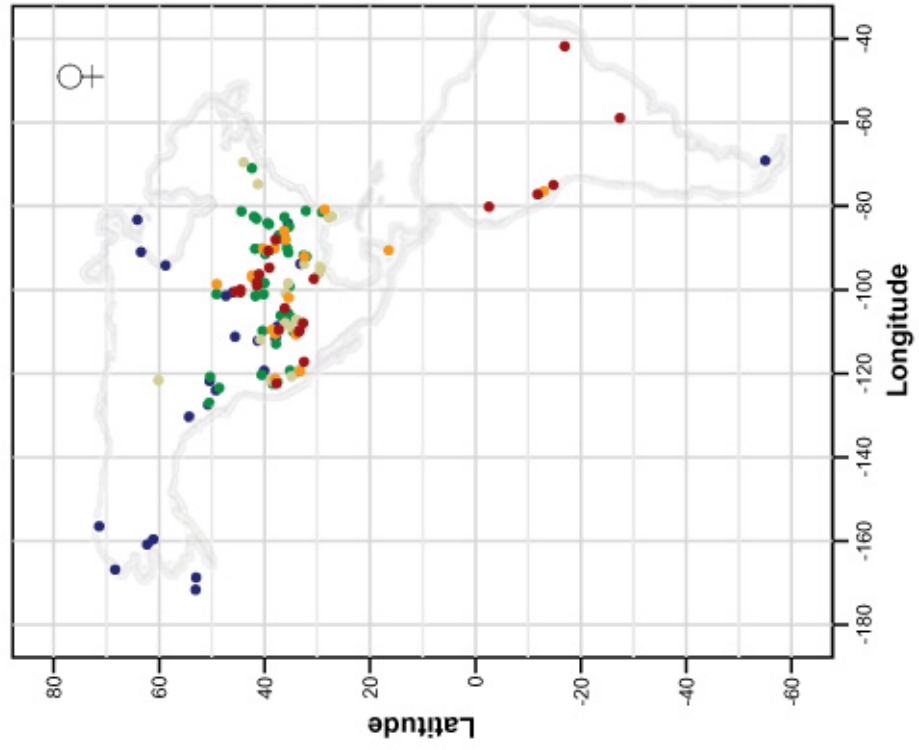


Figure A6.3.2. Male crural index

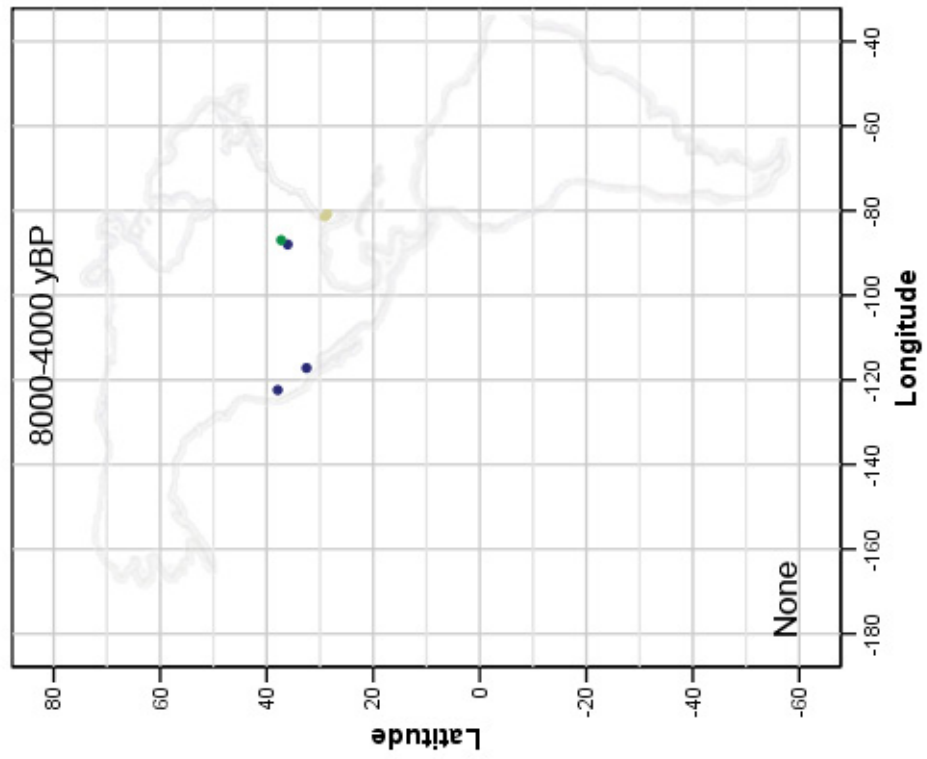
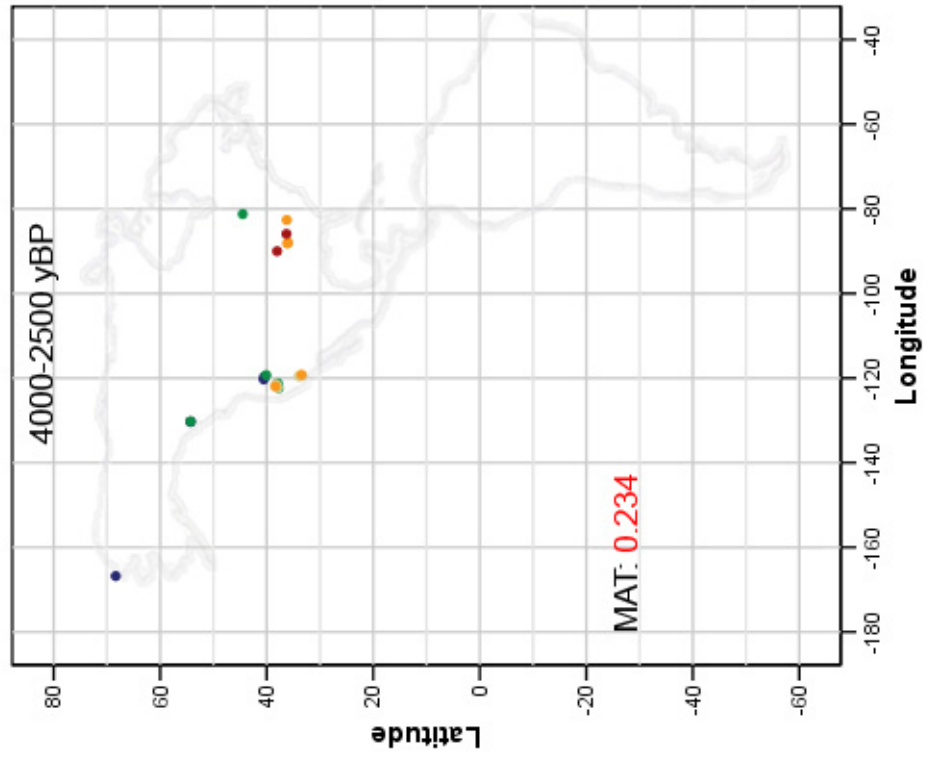


Figure A6.3.4. Male crural index

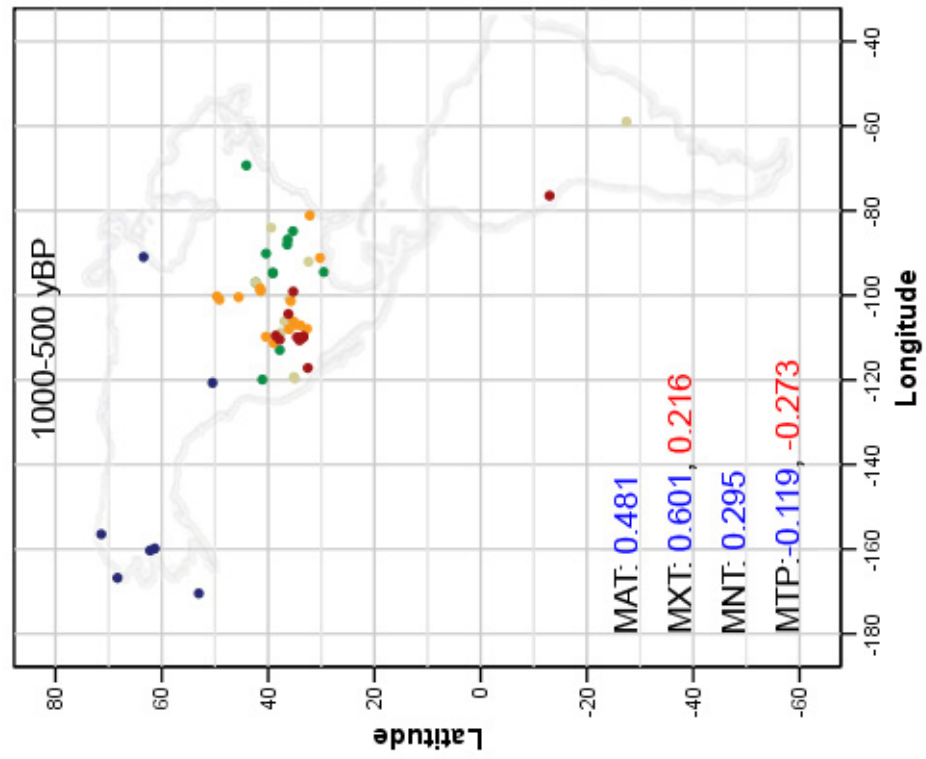
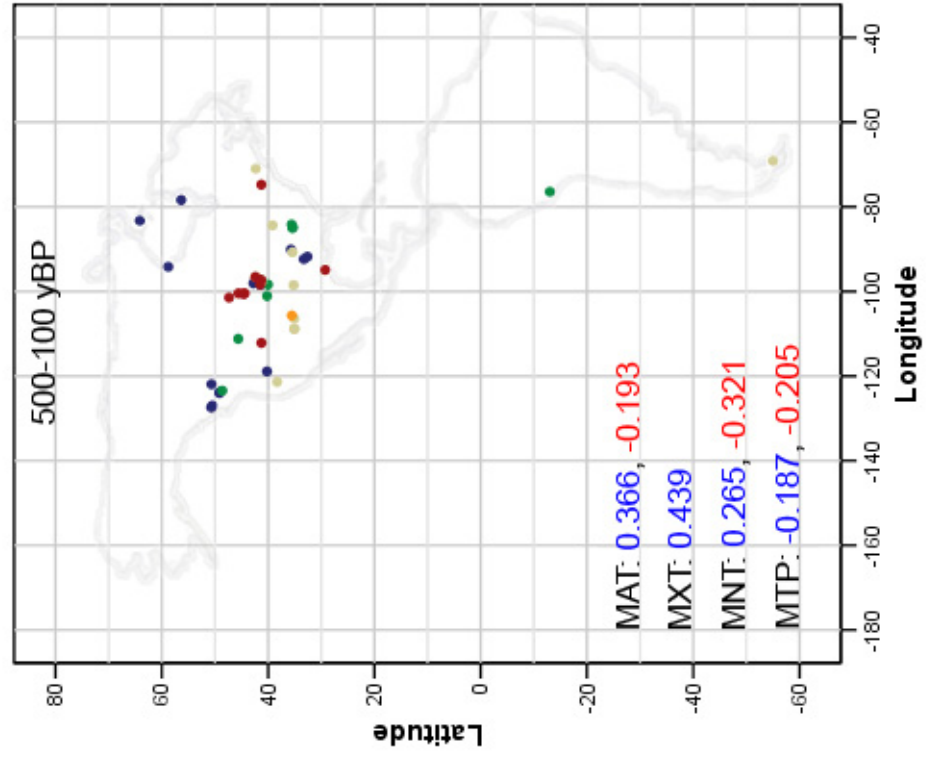


Figure A6.3.5. Female crural index

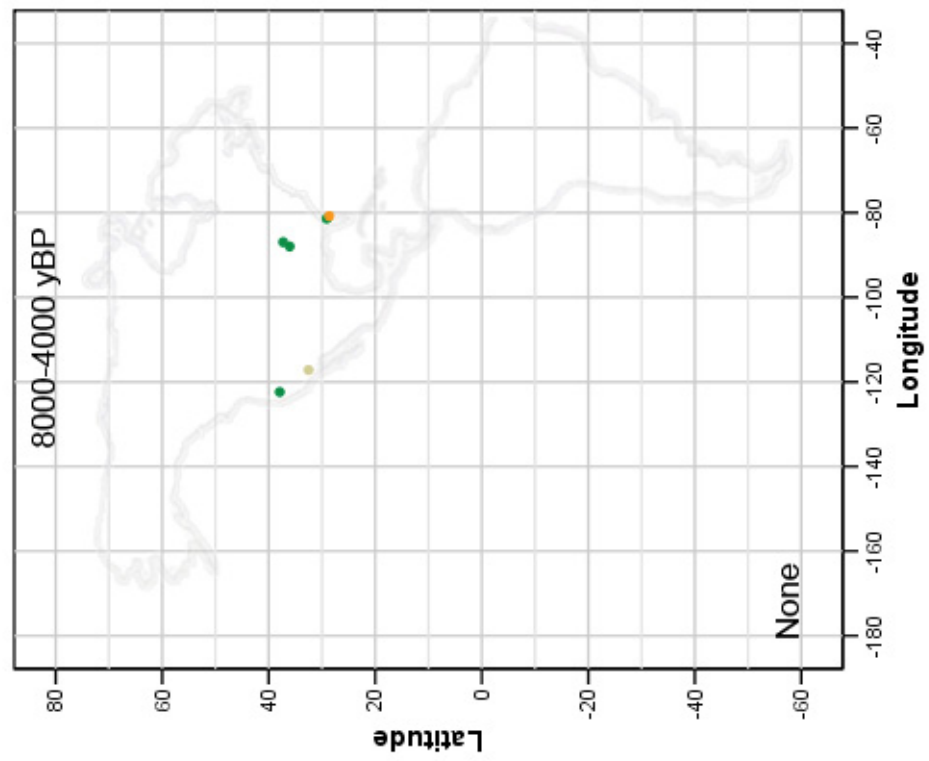
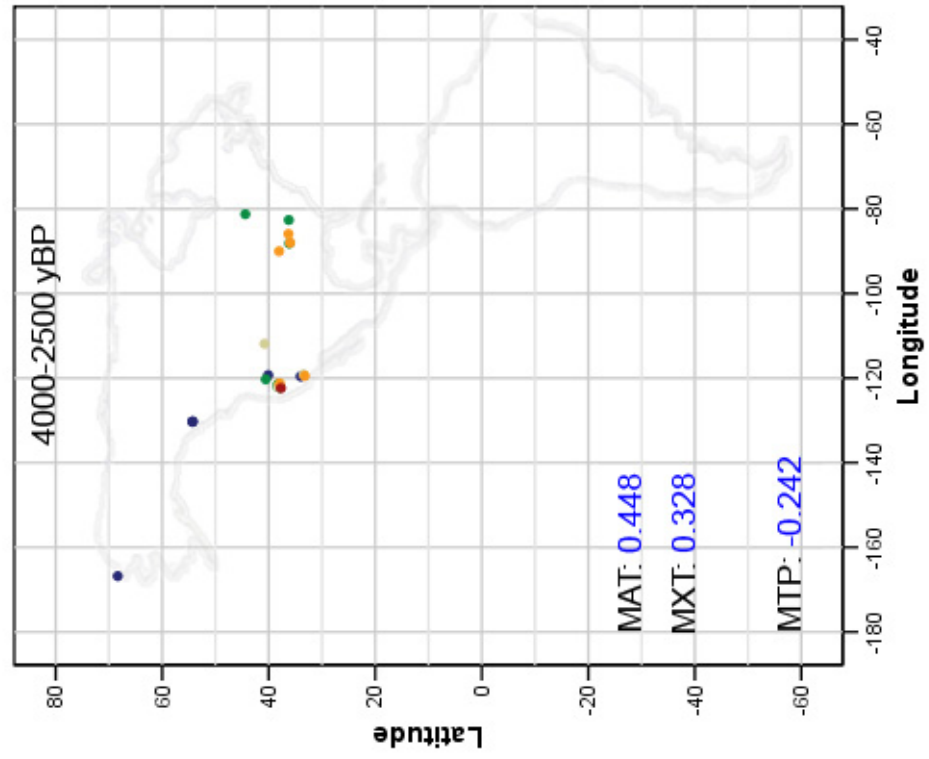


Figure A6.3.6. Female crural index

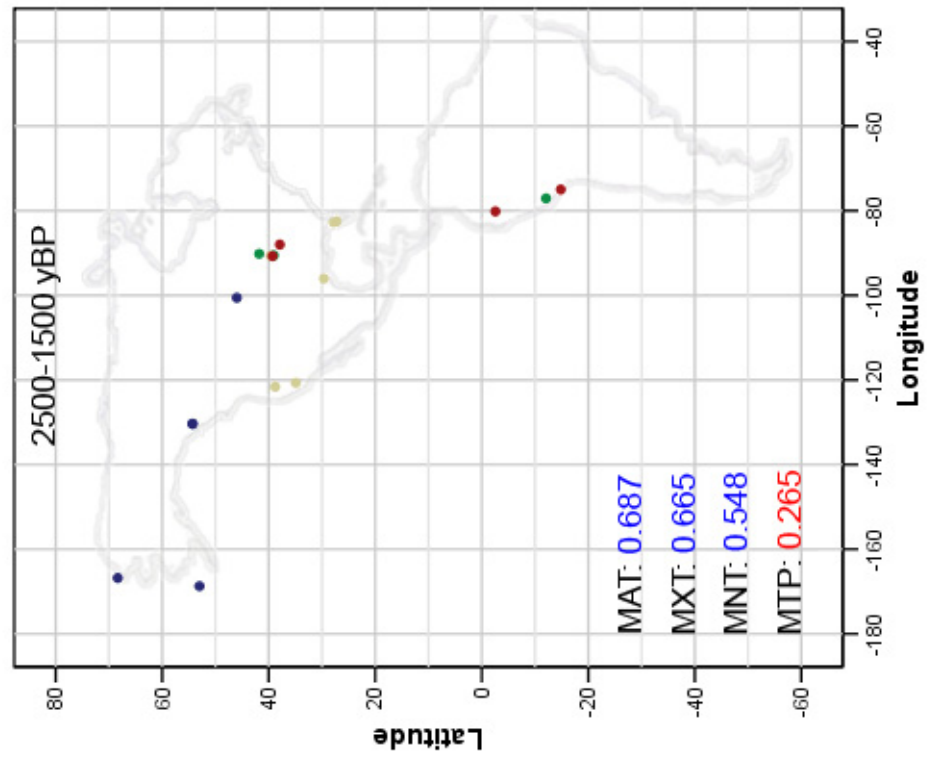
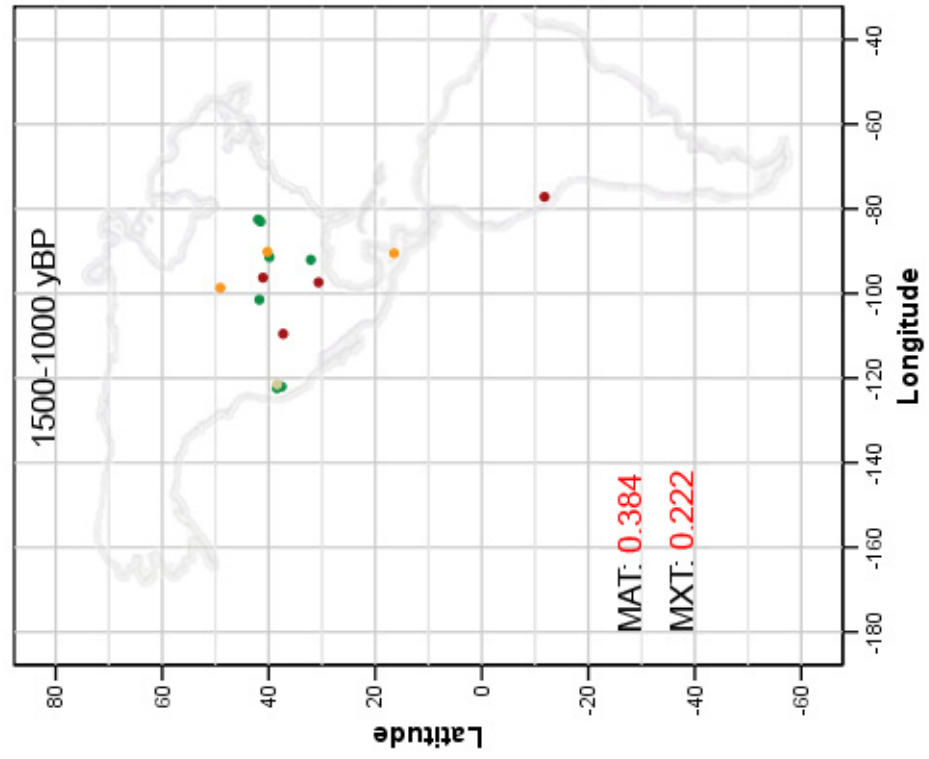


Figure A6.3.7. Female crural index

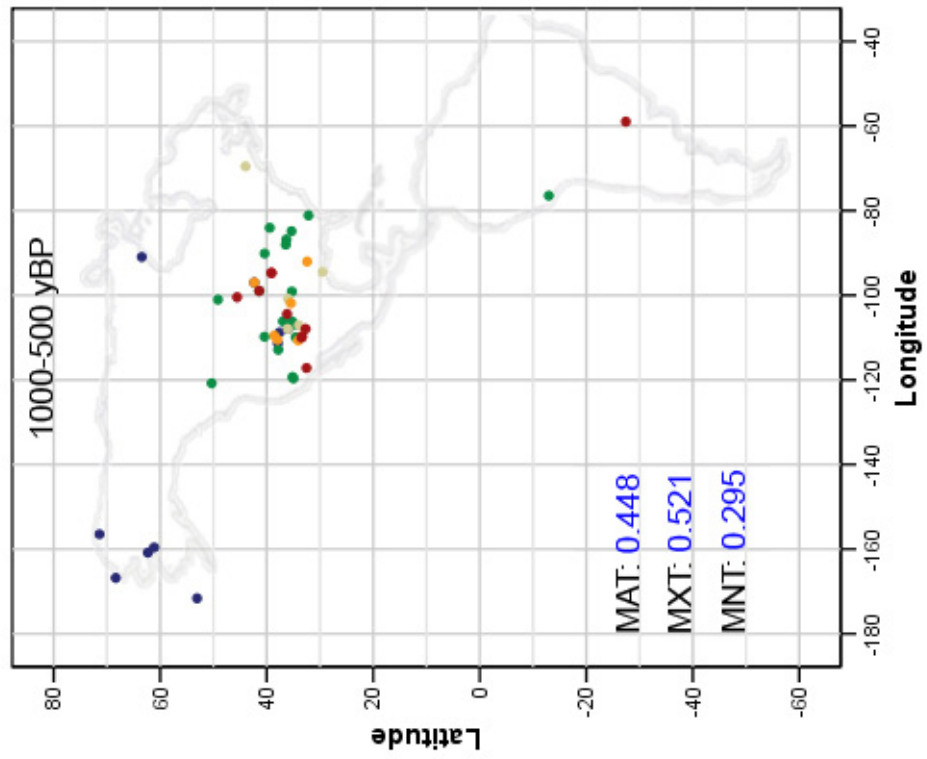
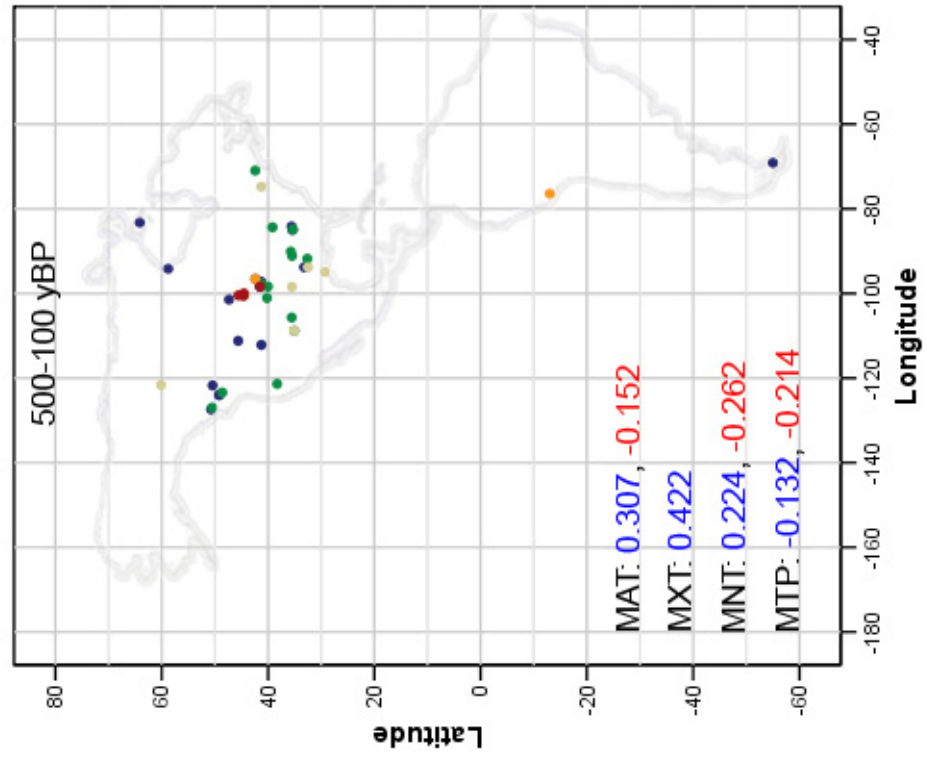


Figure A6.4.1. Relative torso height (RTH), all time periods, all samples

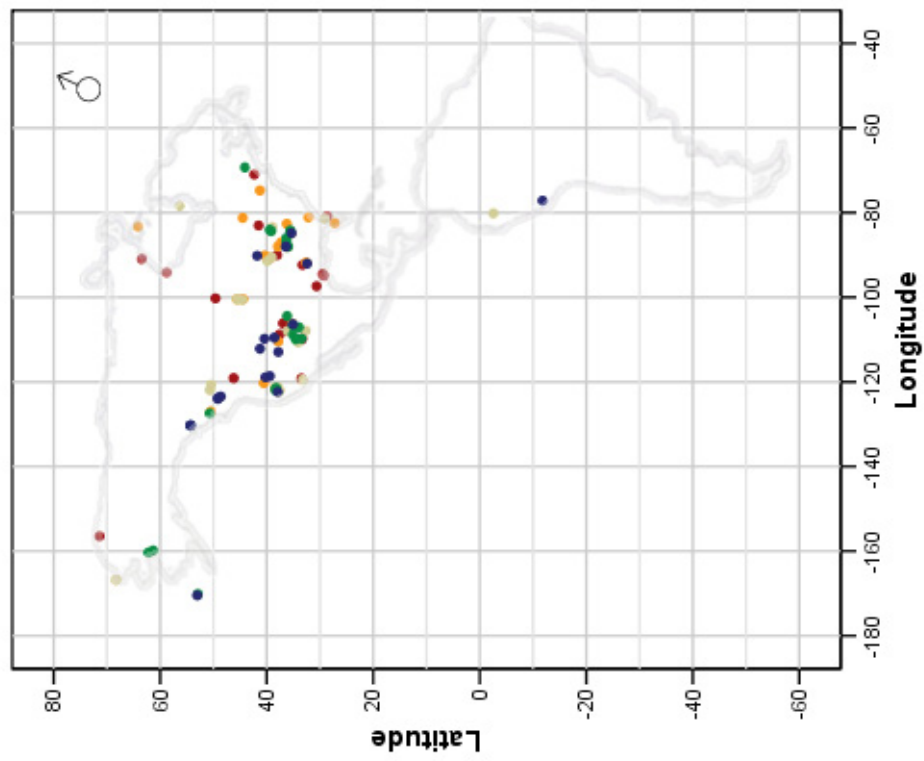
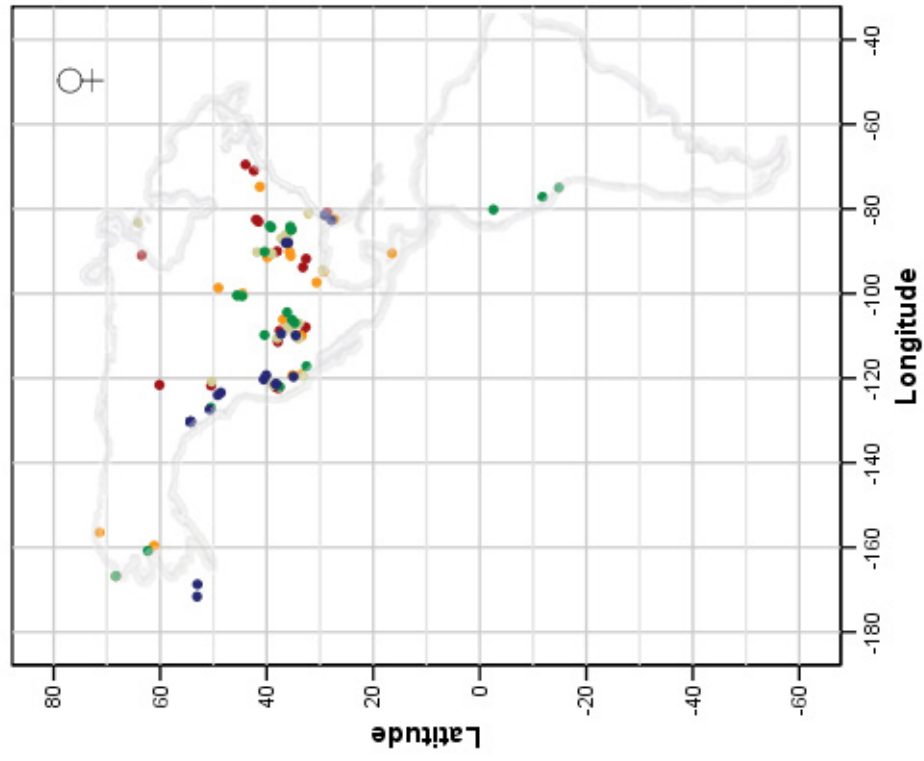


Figure A6.4.2. Male relative torso height (RTH)

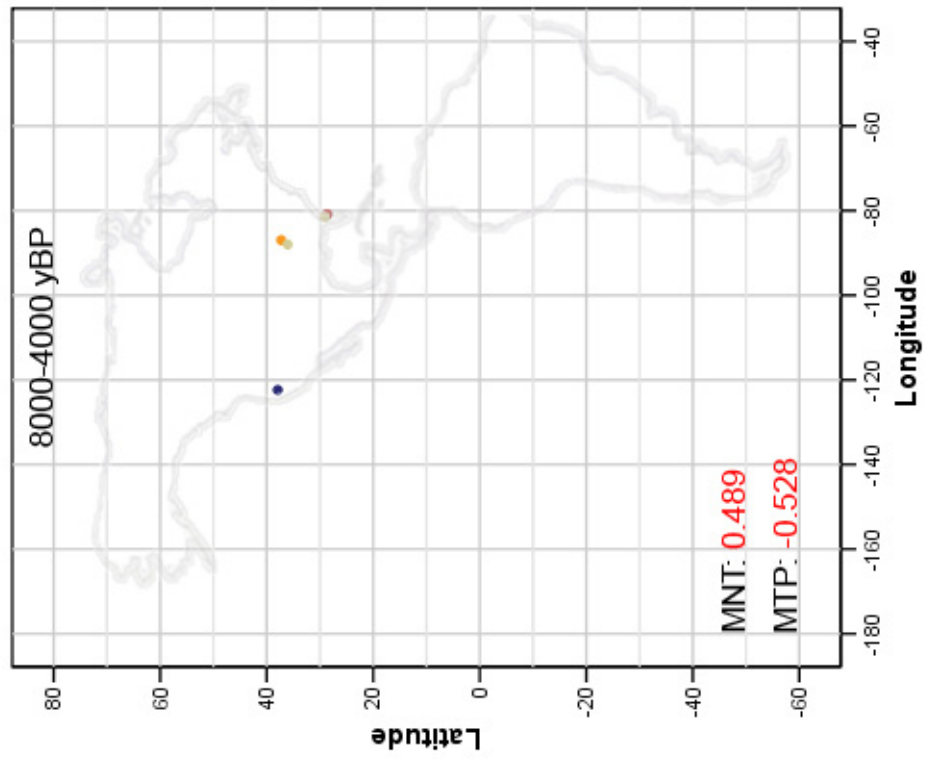
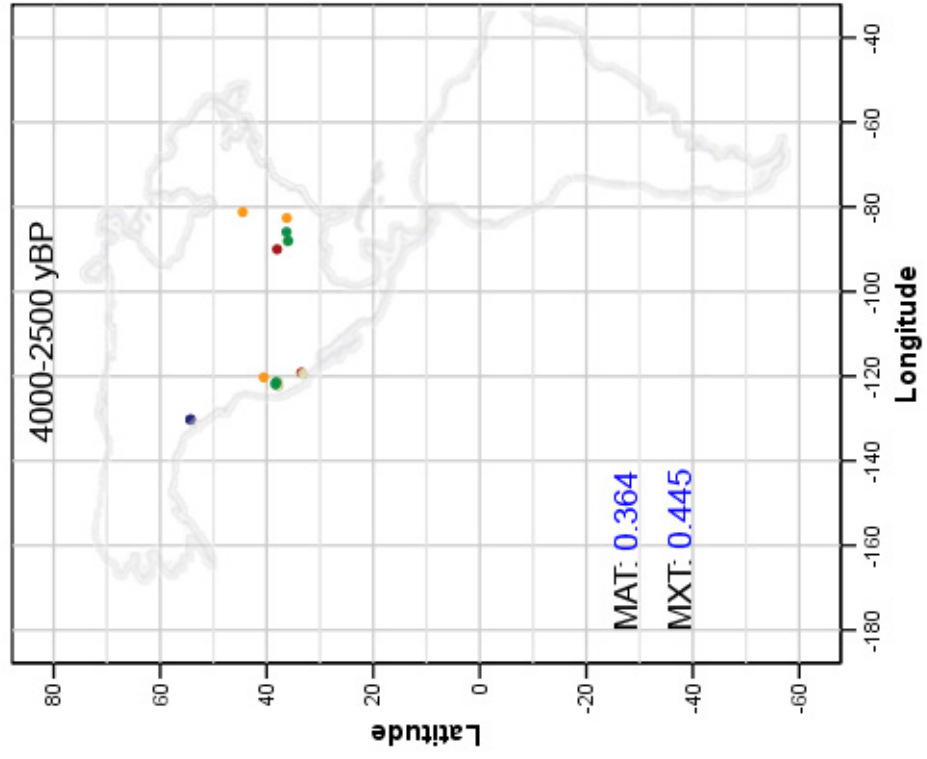


Figure A6.4.3. Male relative torso height (RTH)

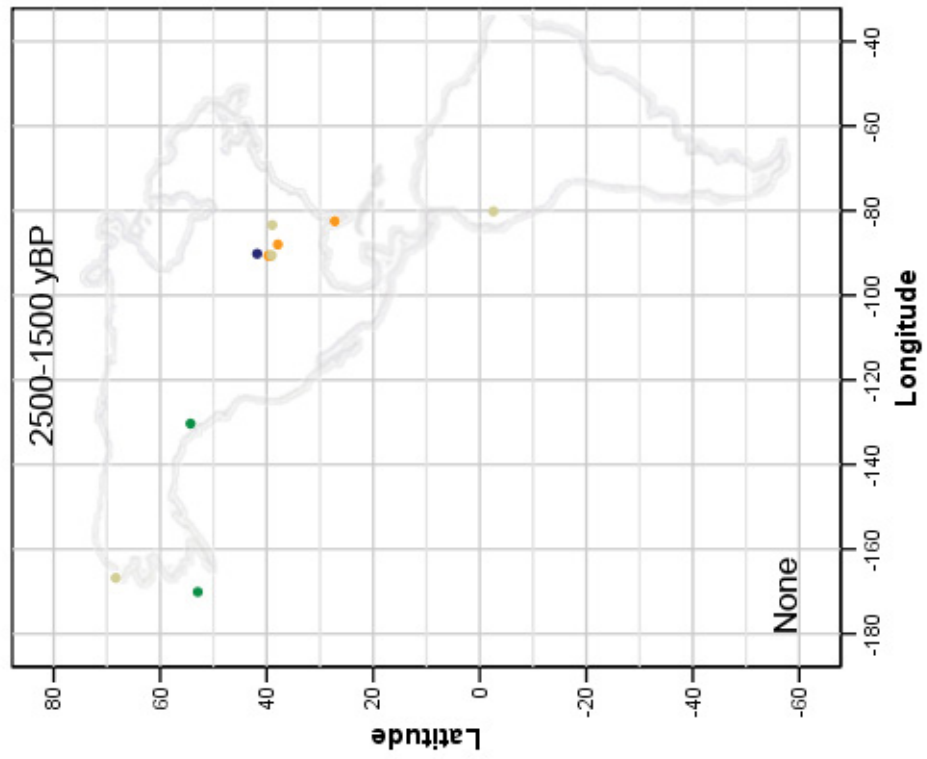
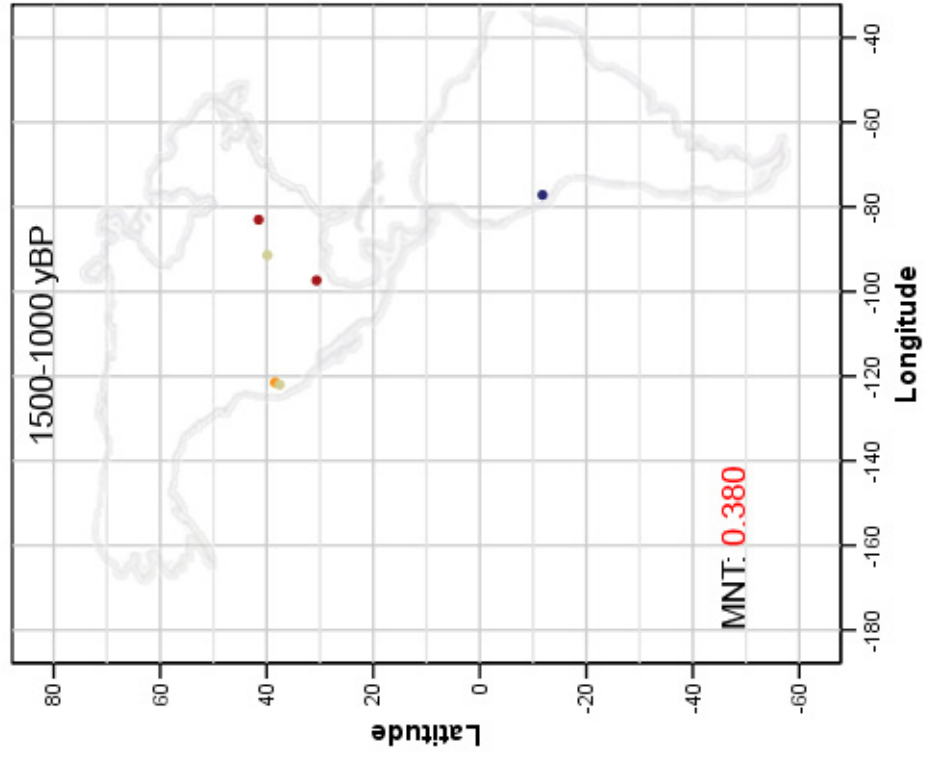


Figure A6.4.4. Male relative torso height (RTH)

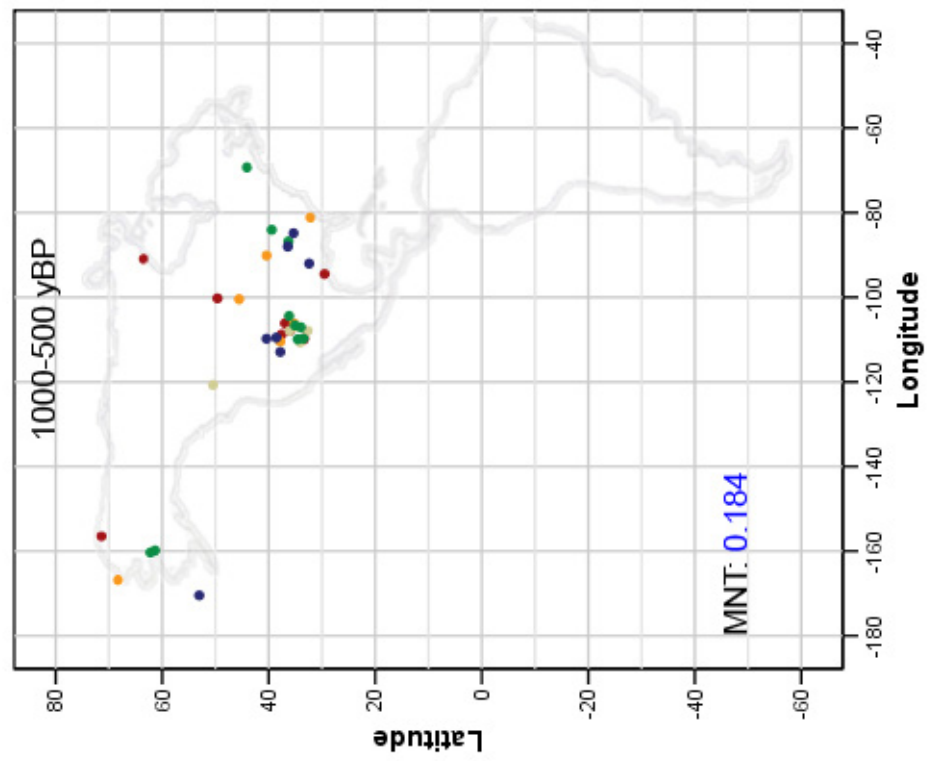
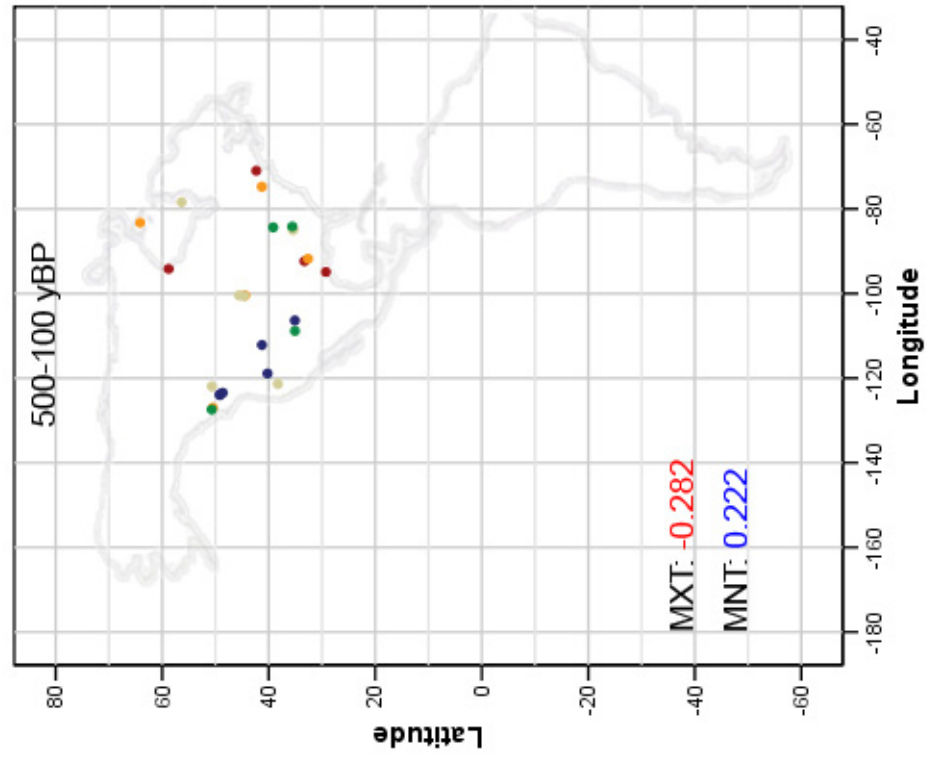


Figure A6.4.5. Female relative torso height (RTH)

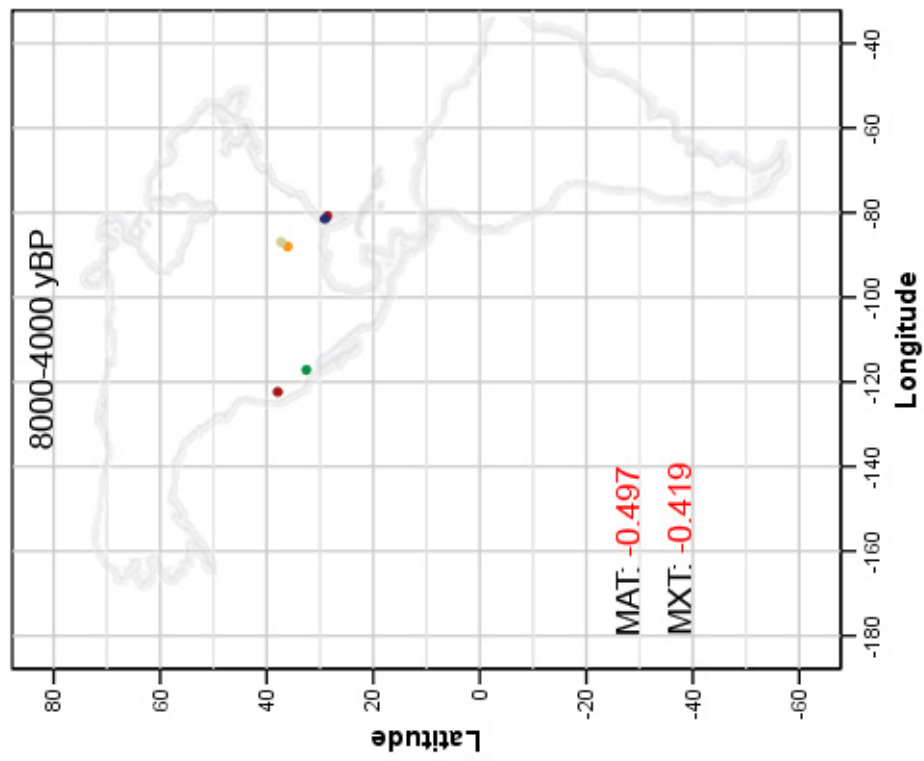
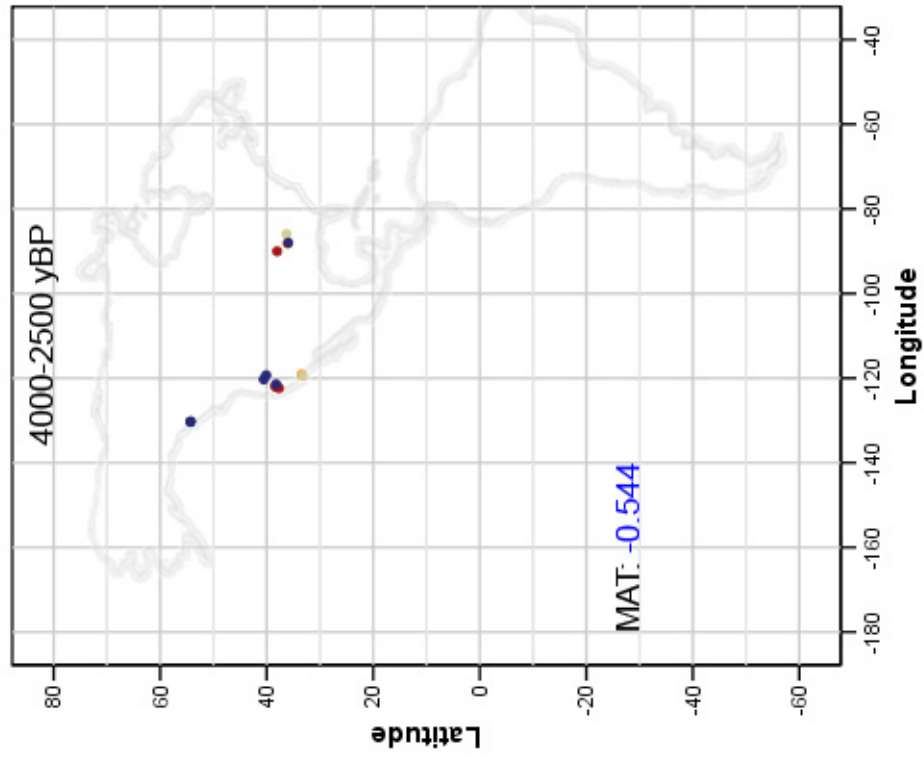


Figure A6.4.6. Female relative torso height (RTH)

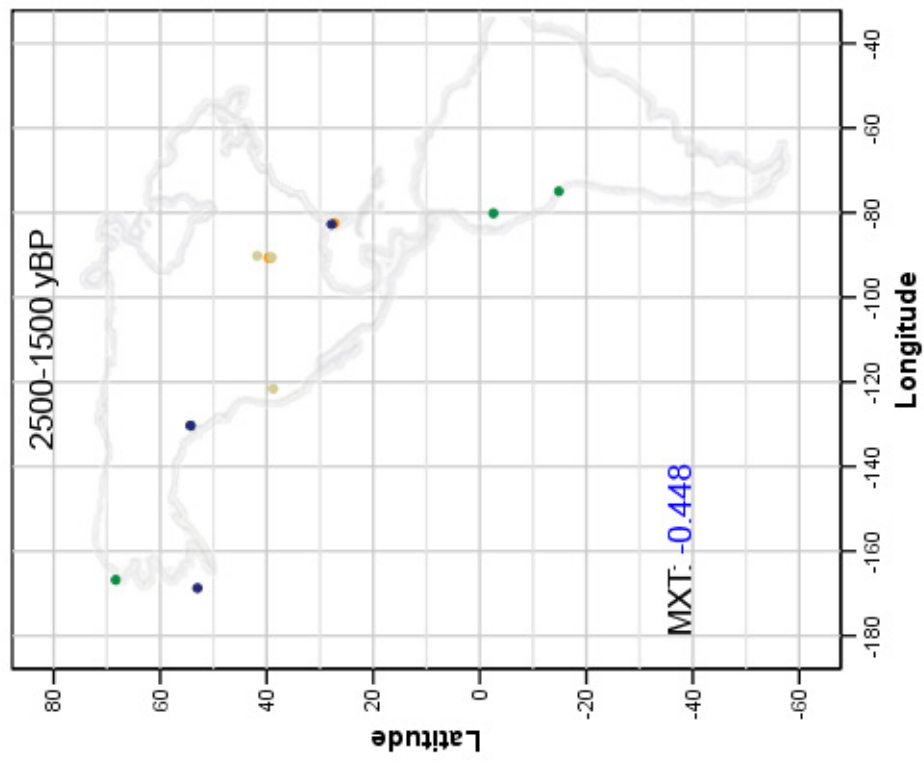
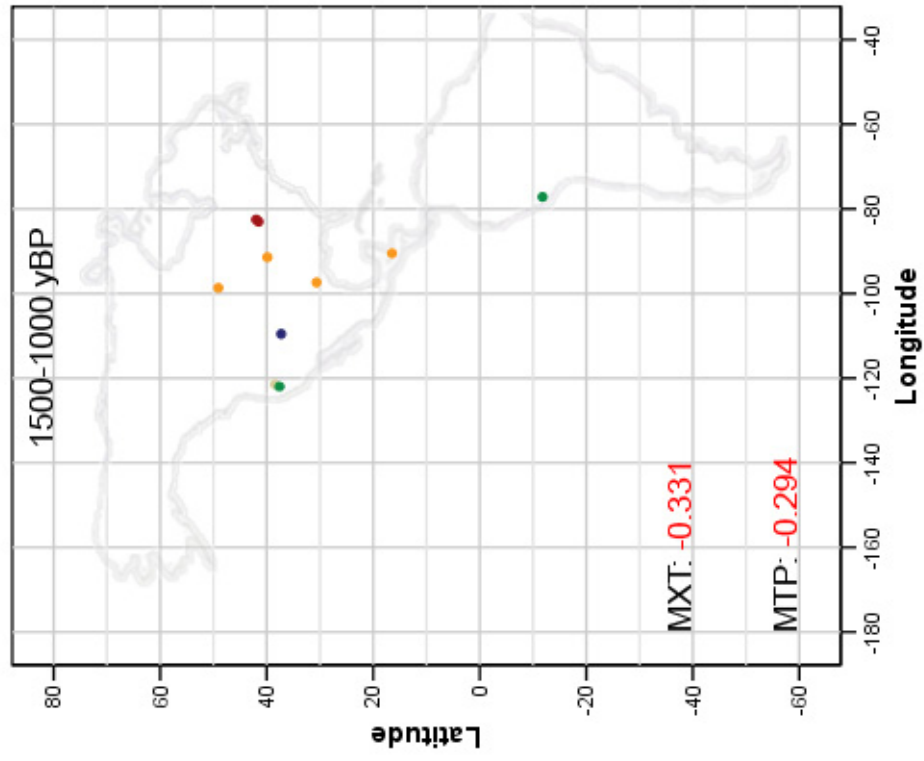


Figure A6.4.7. Female relative torso height (RTH)

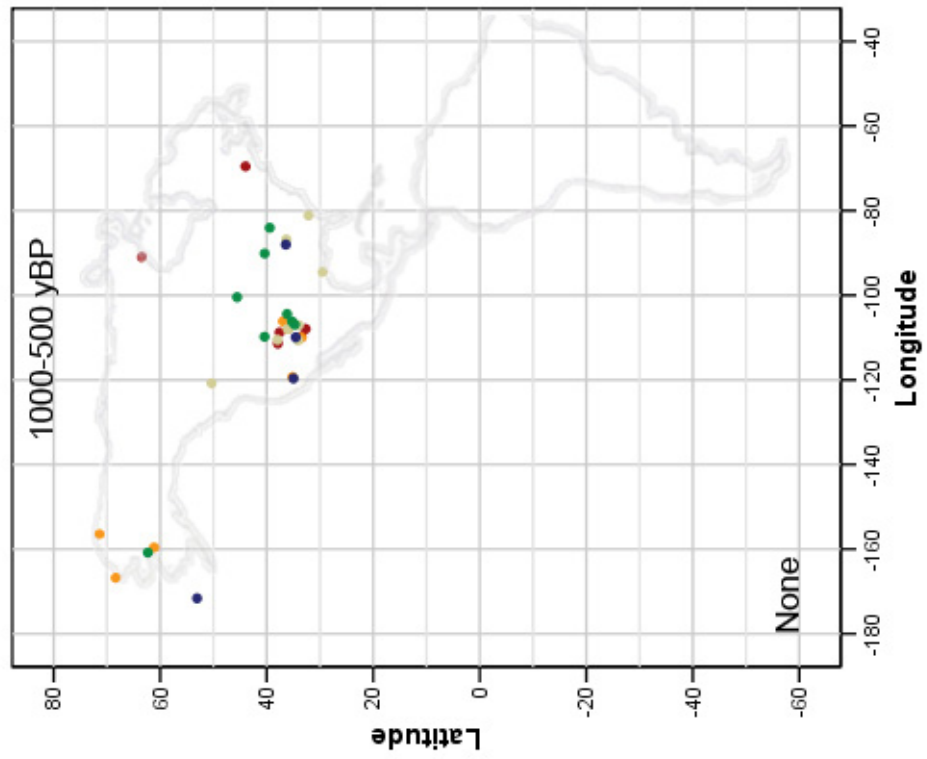
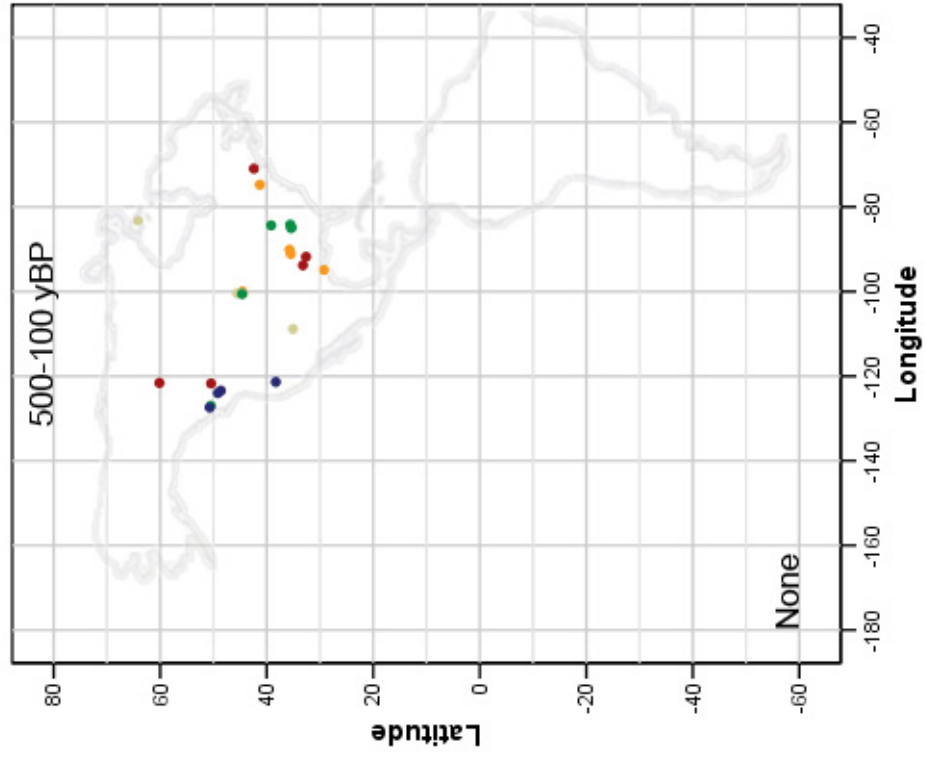


Figure A6.5.1. Bi-iliac breadth (BIB), all time periods, all samples

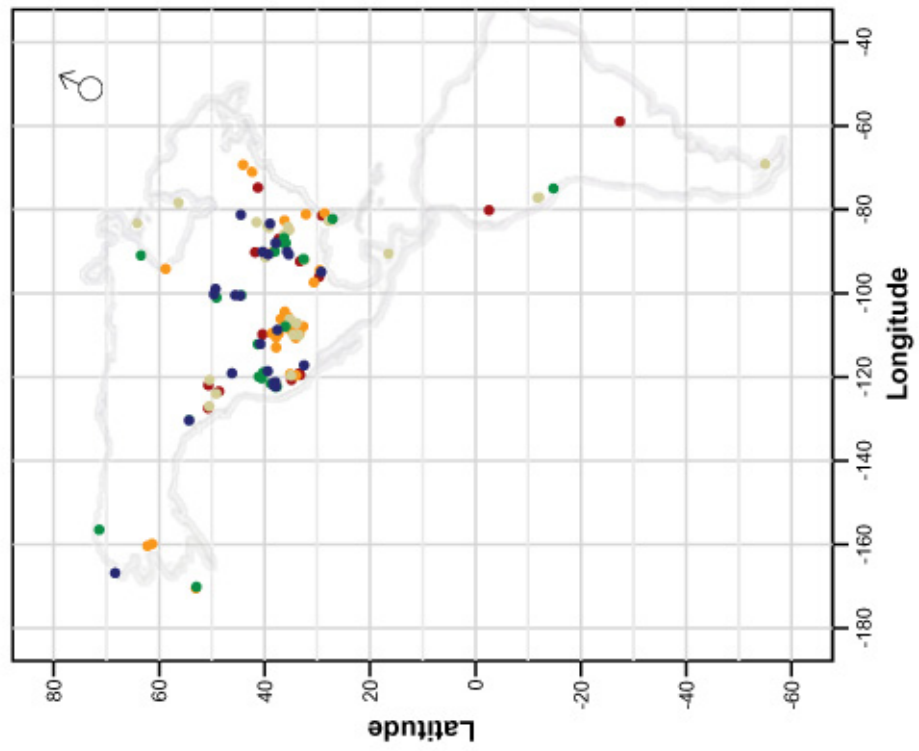
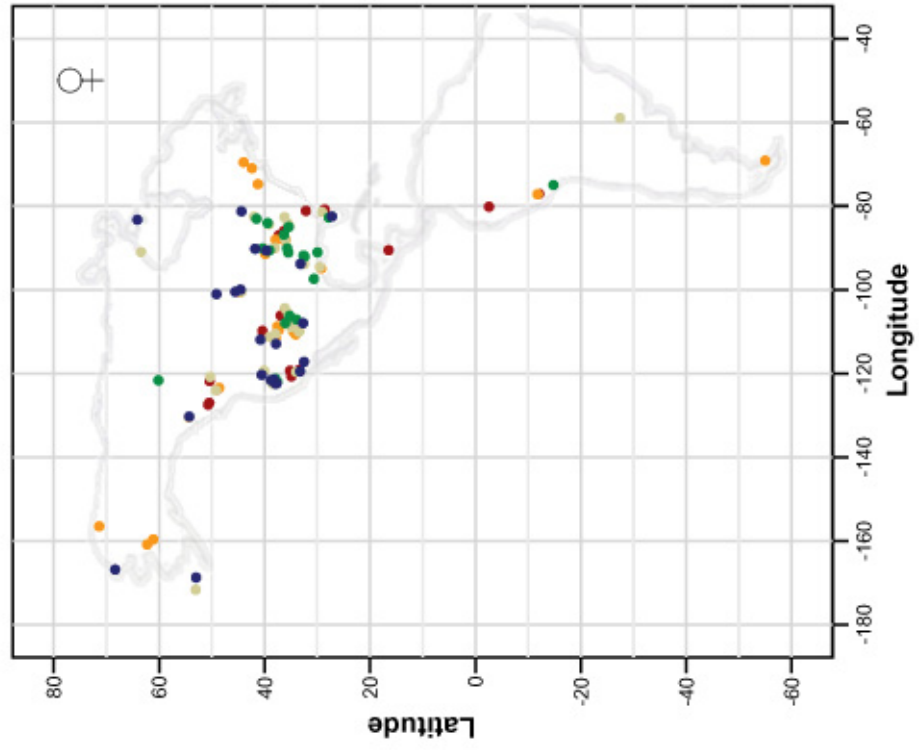


Figure A6.5.2. Male bi-iliac breadth (BIB)

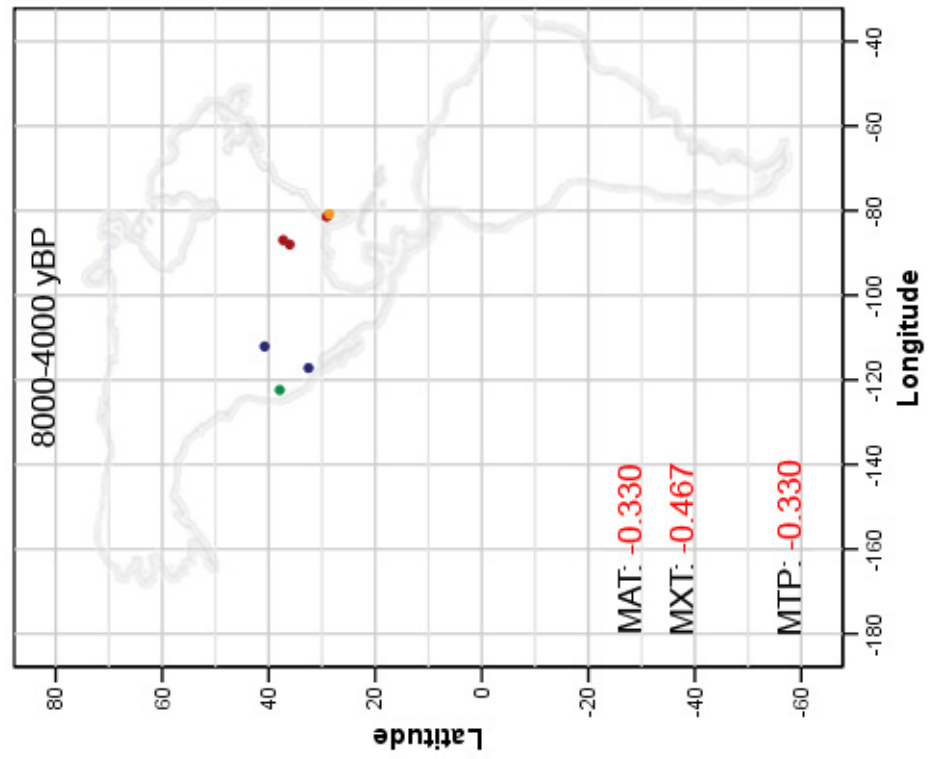
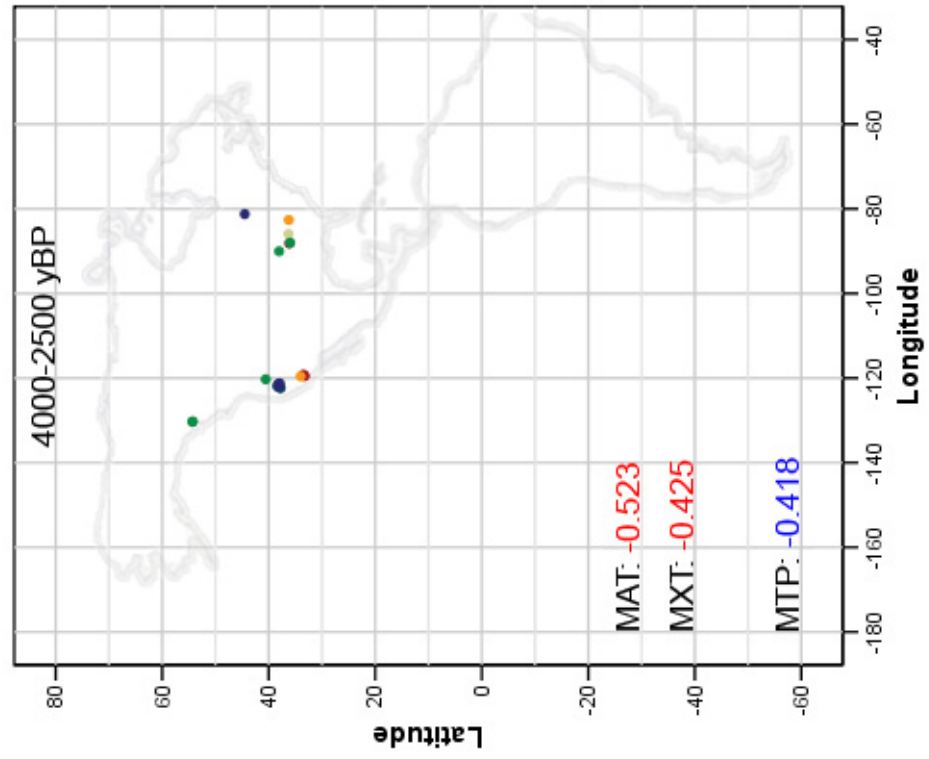


Figure A6.5.3. Male bi-iliac breadth (BIB)

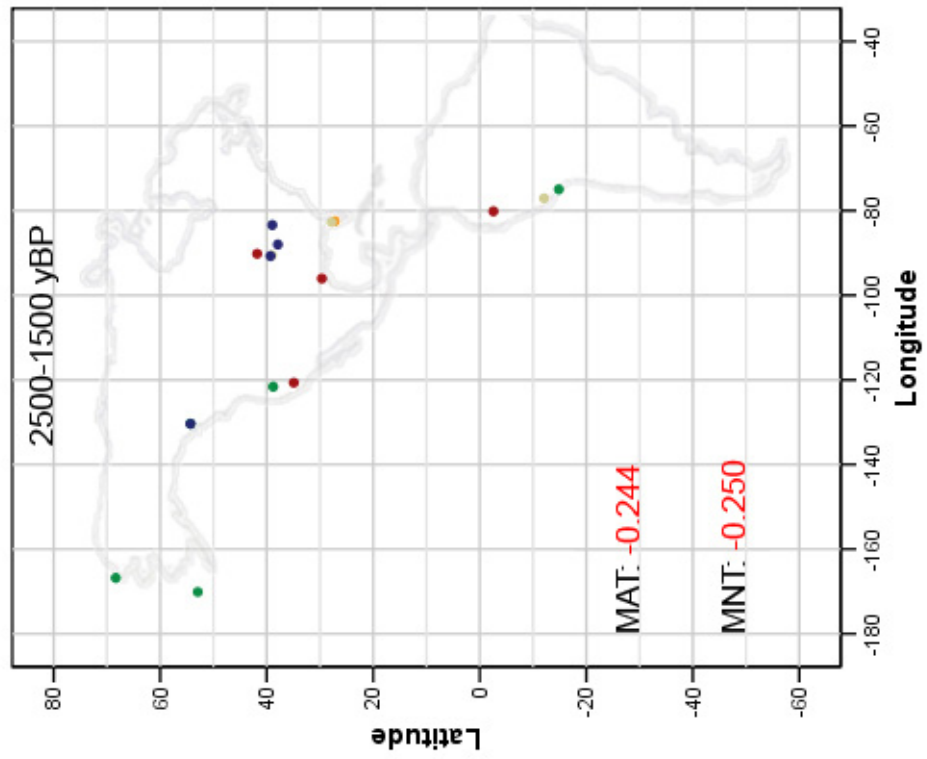
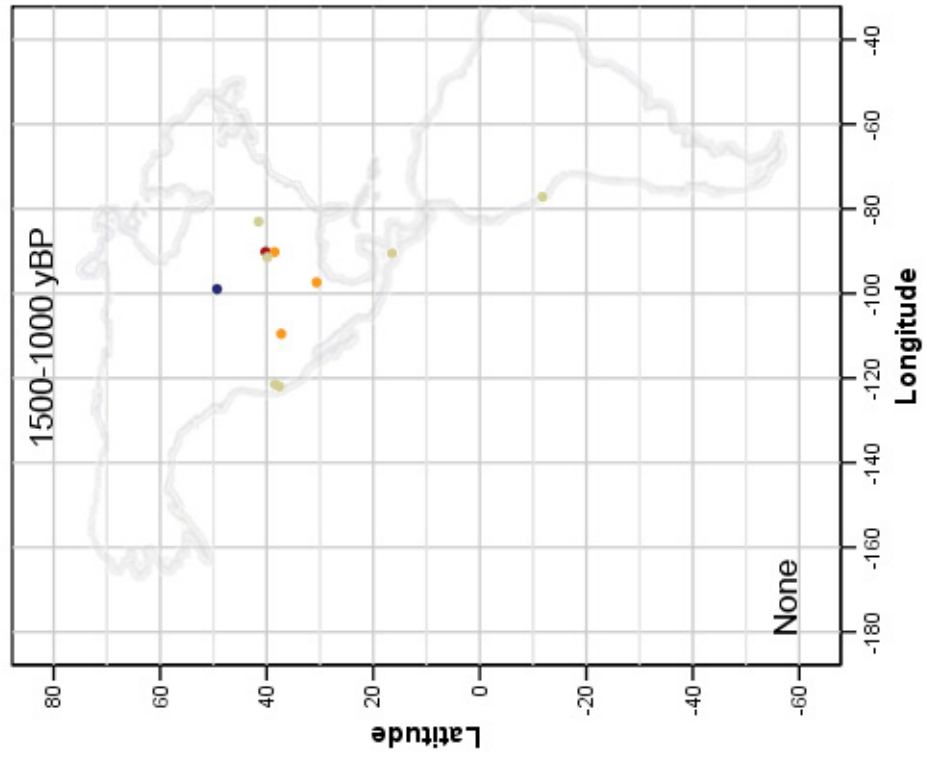


Figure A6.5.4. Male bi-iliac breadth (BIB)

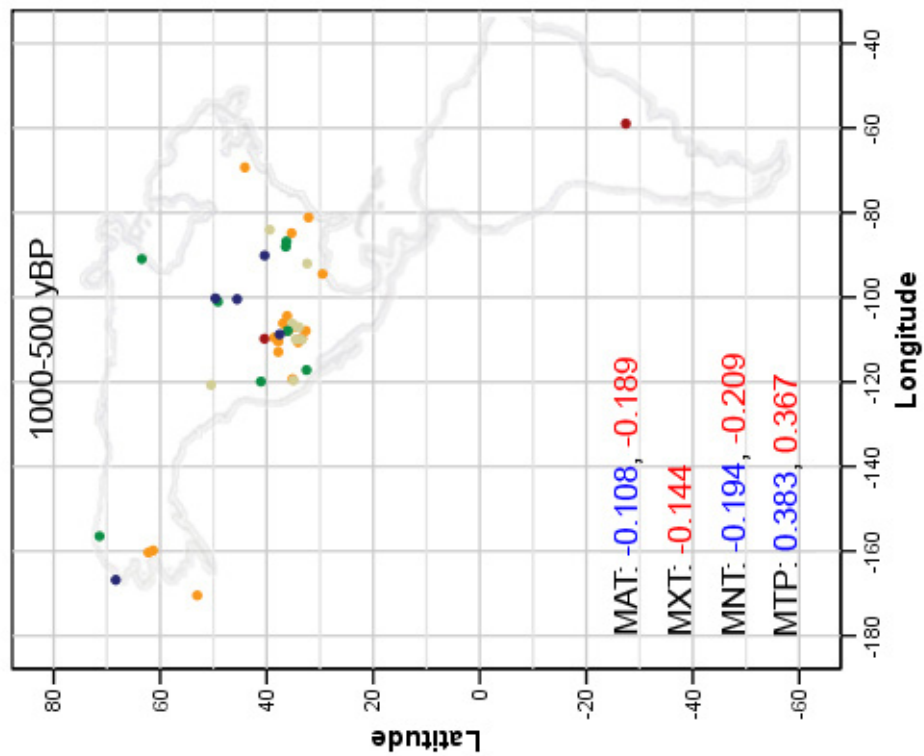
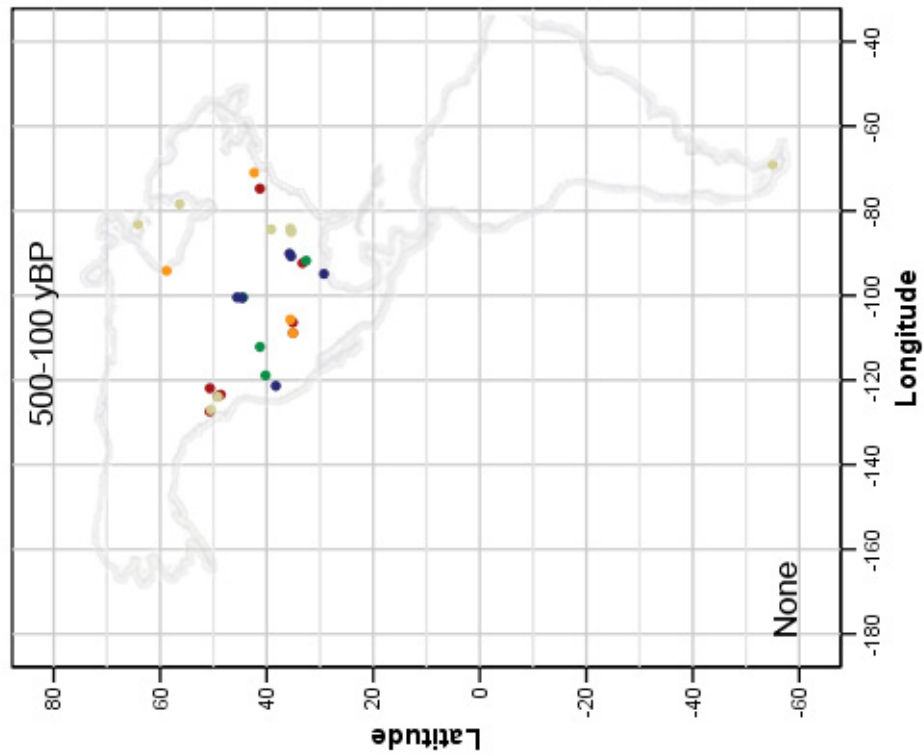


Figure A6.5.5. Female bi-iliac breadth (BIB)

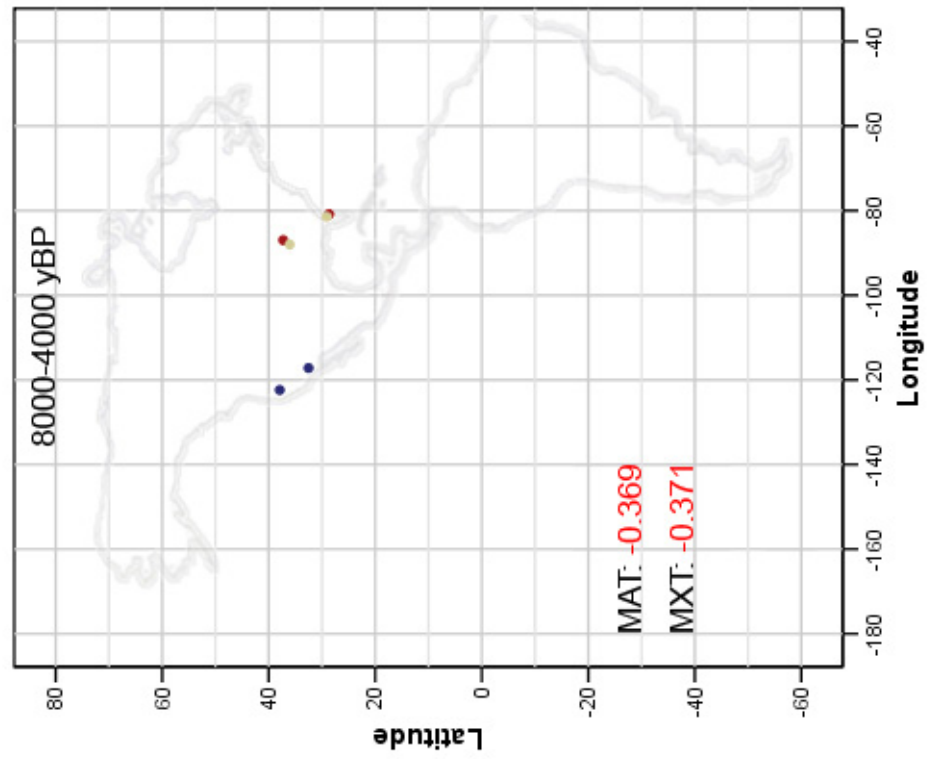
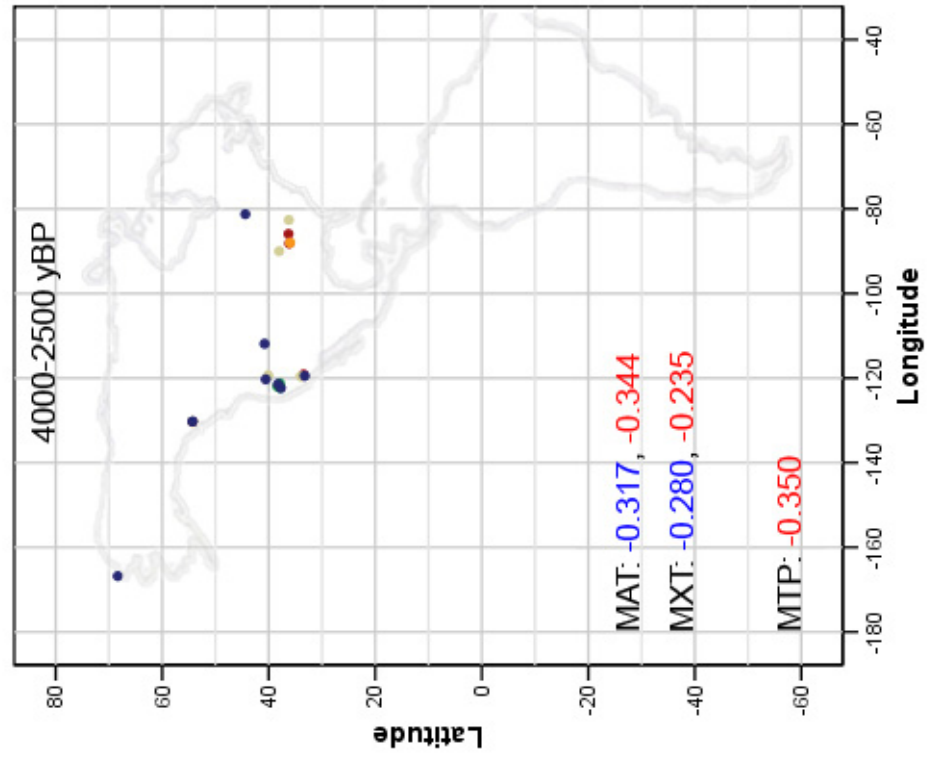


Figure A6.5.6. Female bi-iliac breadth (BIB)

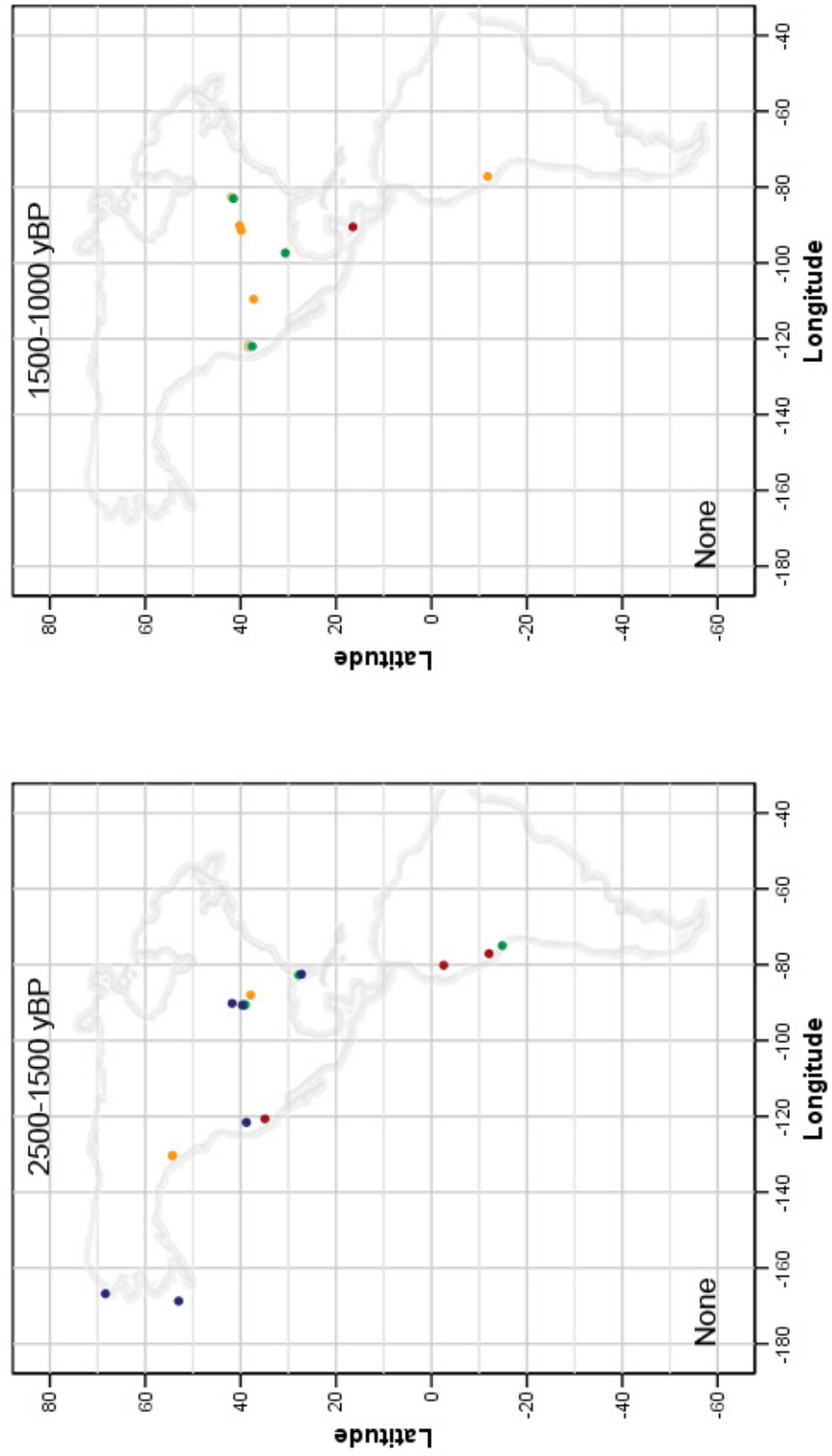


Figure A6.5.7. Female bi-iliac breadth (BIB)

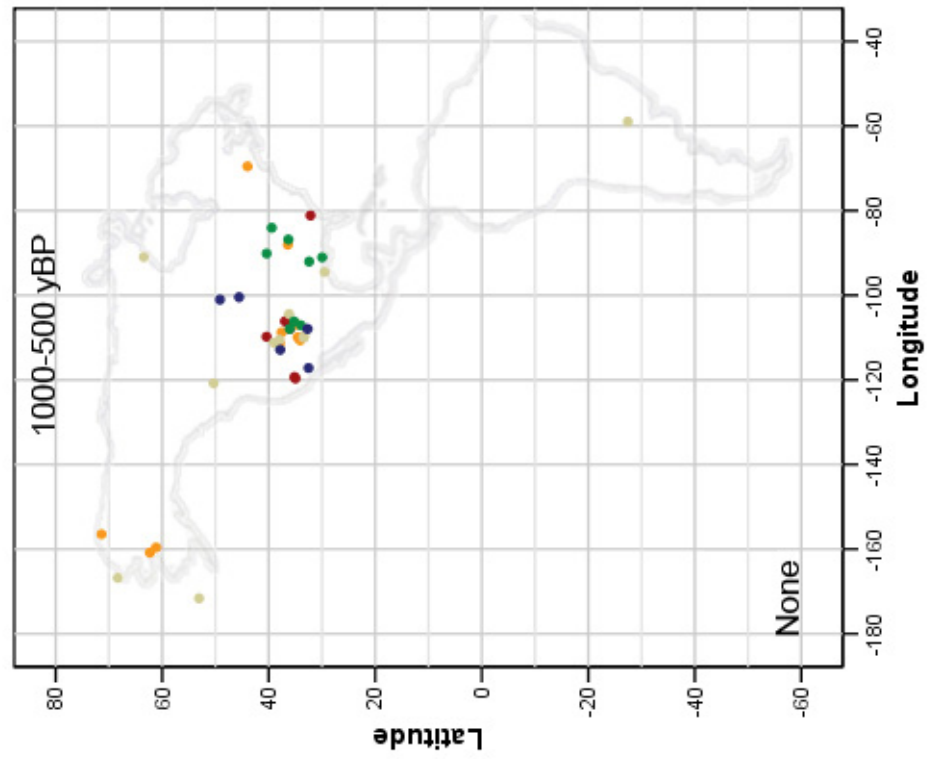
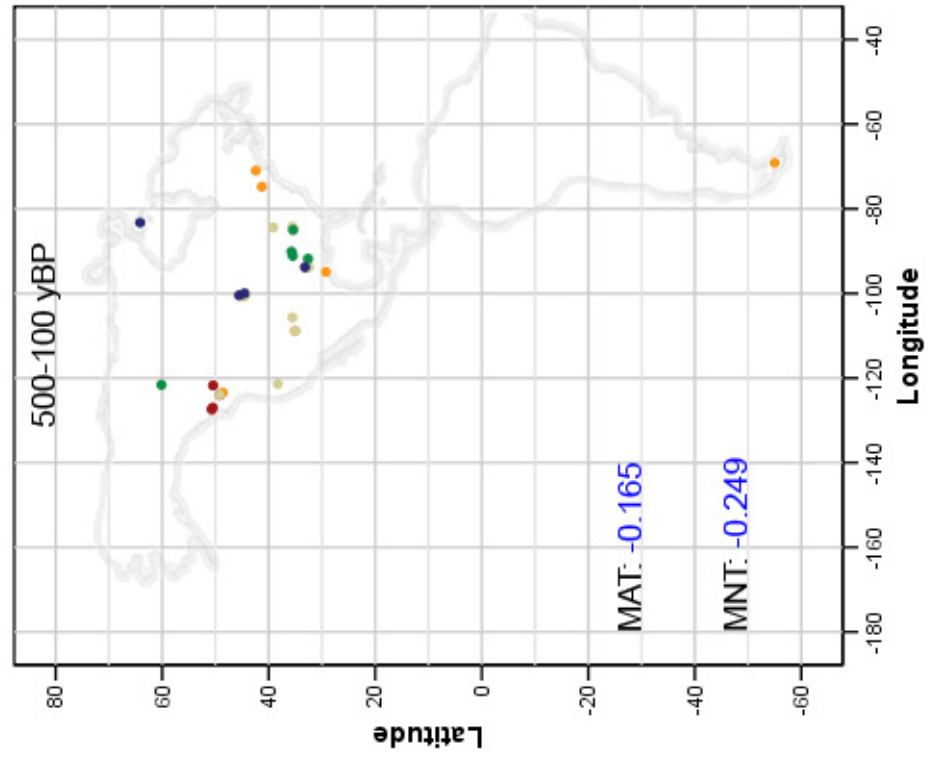


Figure A6.6.1. Body mass (FHD BME), all time periods, all samples

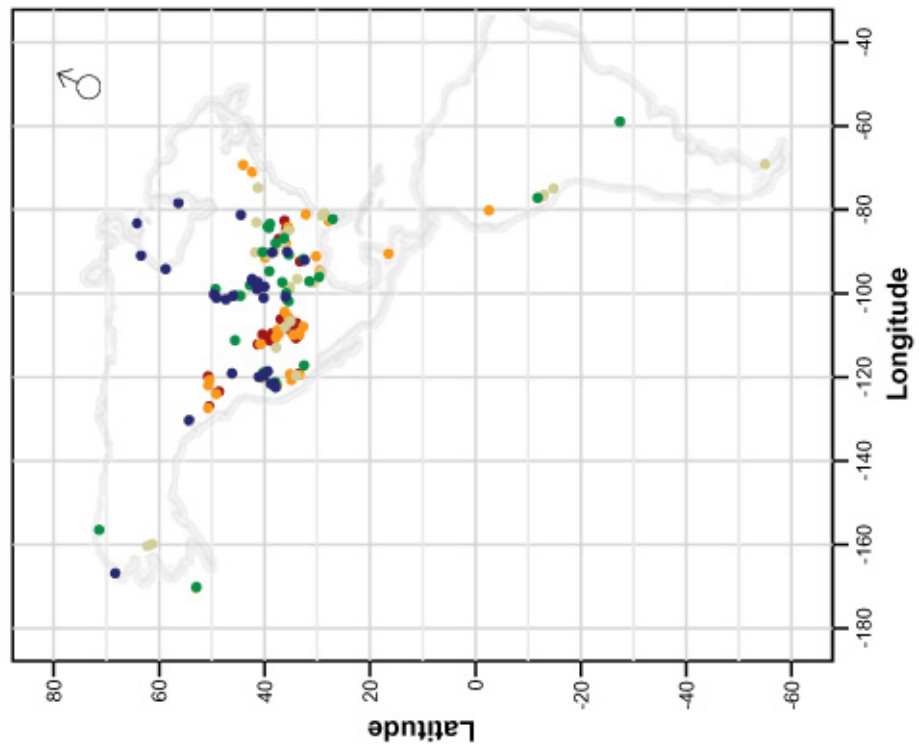
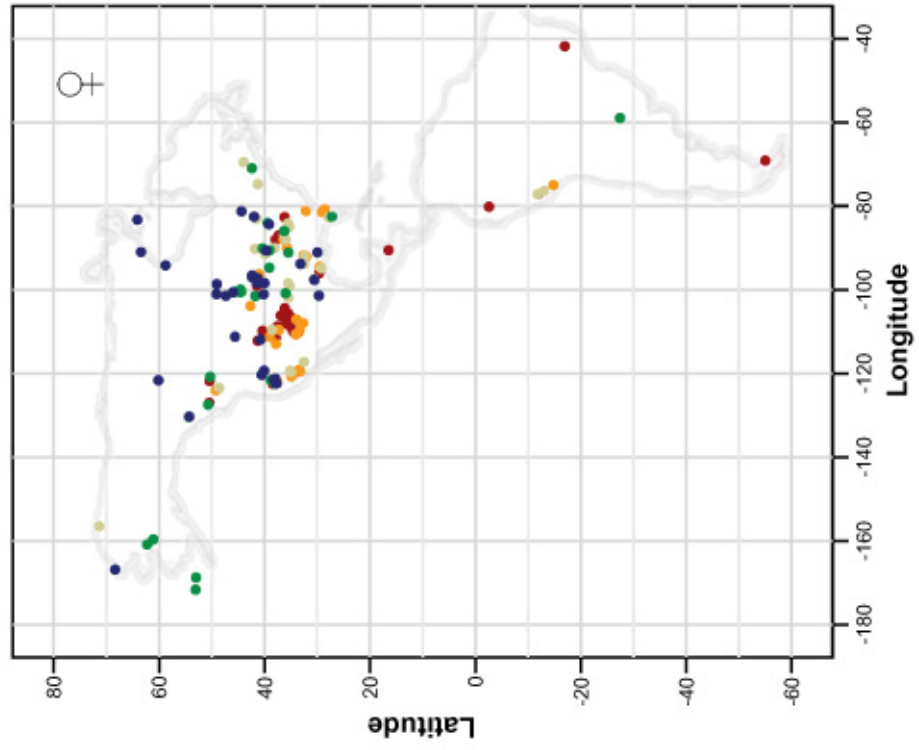


Figure A6.6.2. Male body mass (FHD BME)

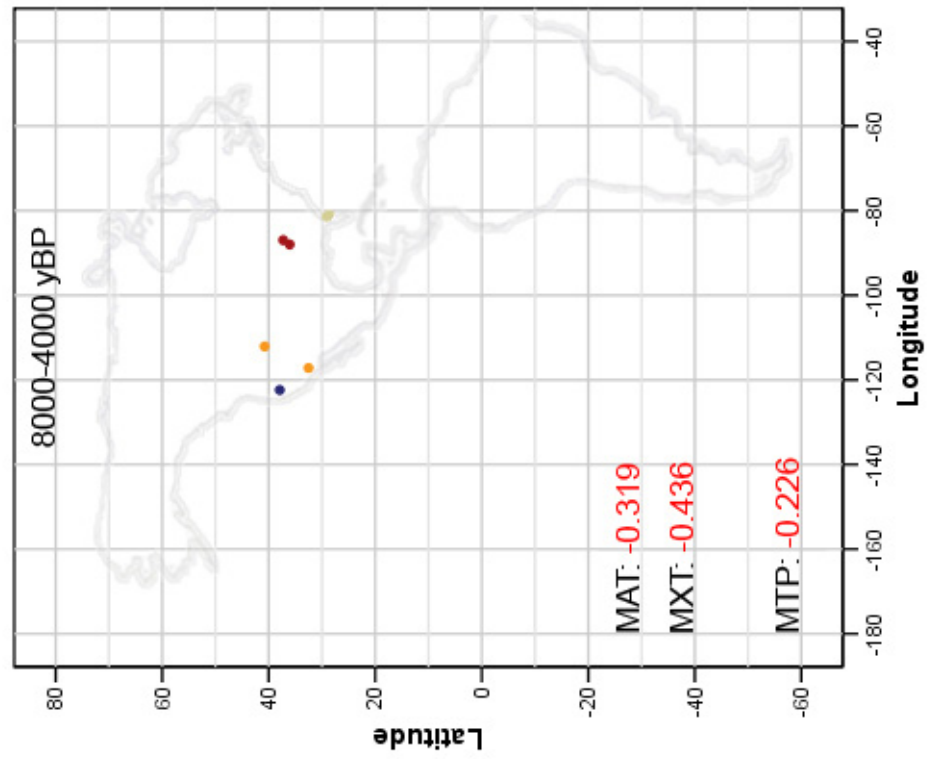
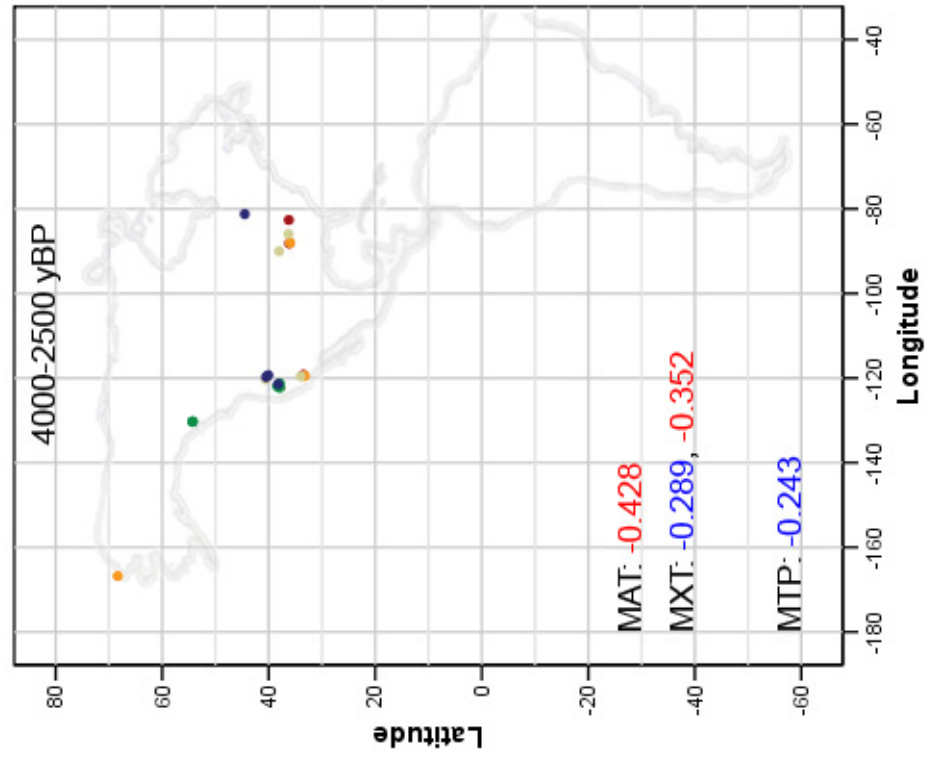


Figure A6.6.3. Male body mass (FHD BME)

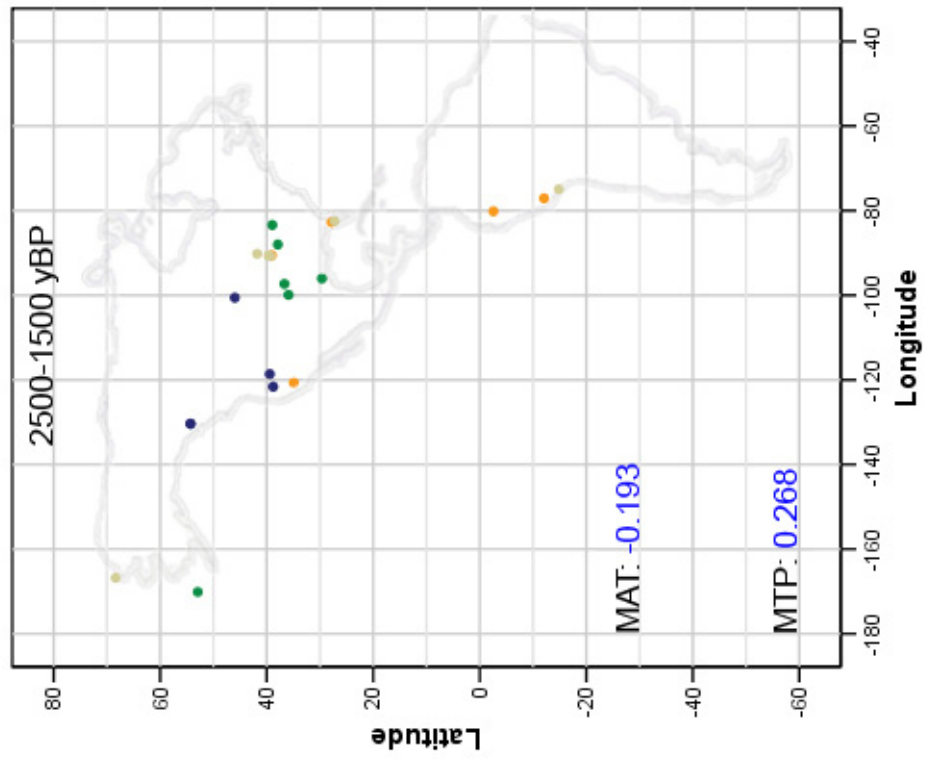
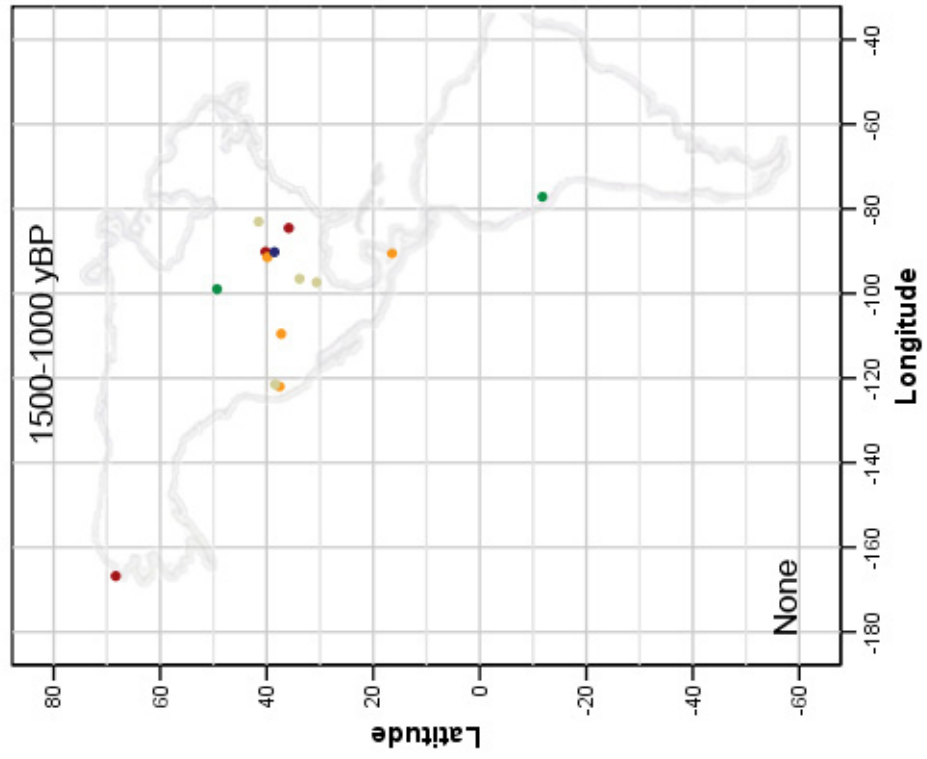


Figure A6.6.4. Male body mass (FHD BME)

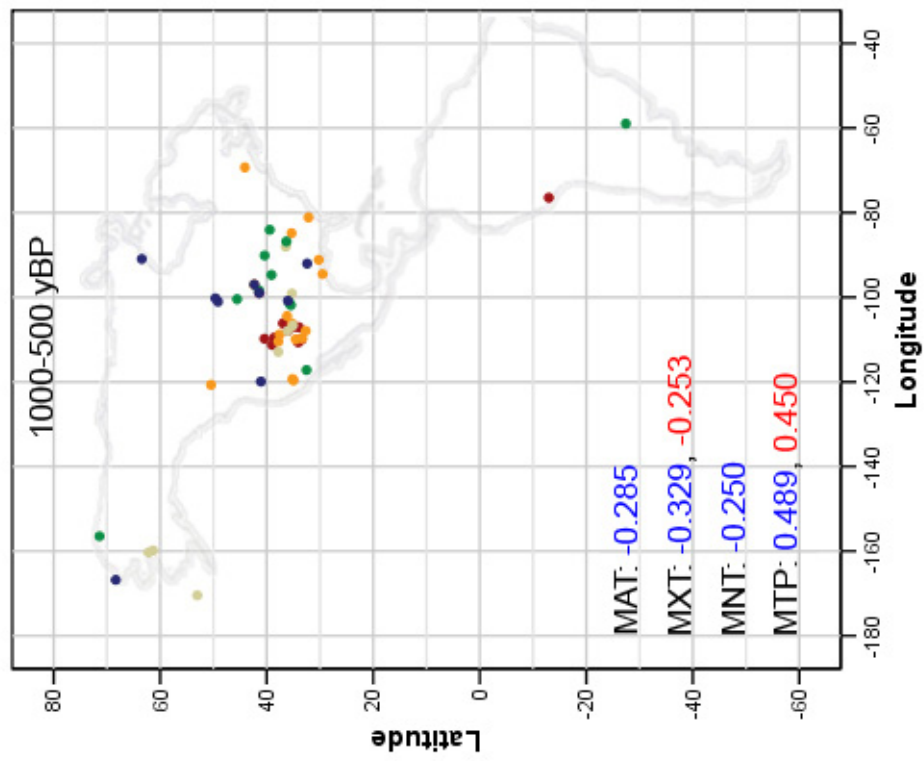
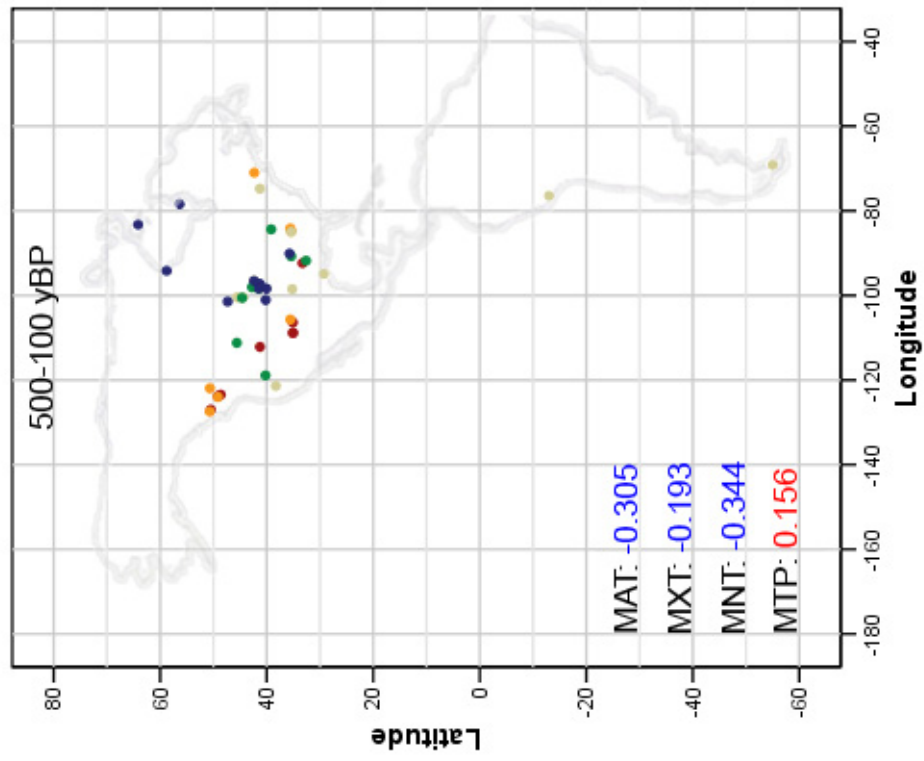


Figure A6.6.5. Female body mass (FHD BME)

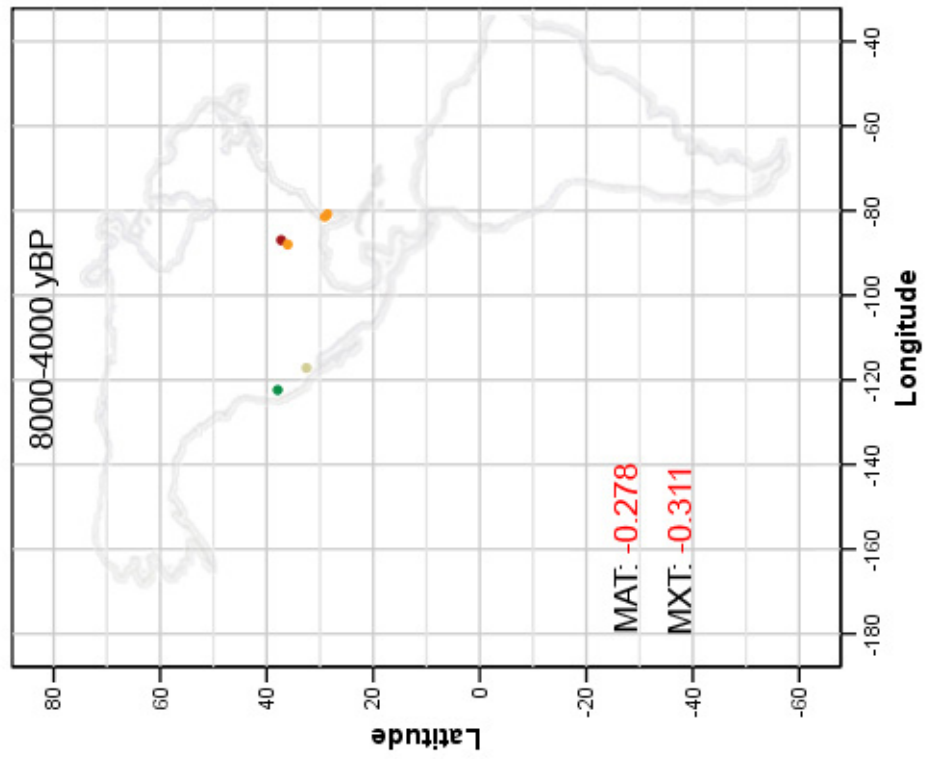
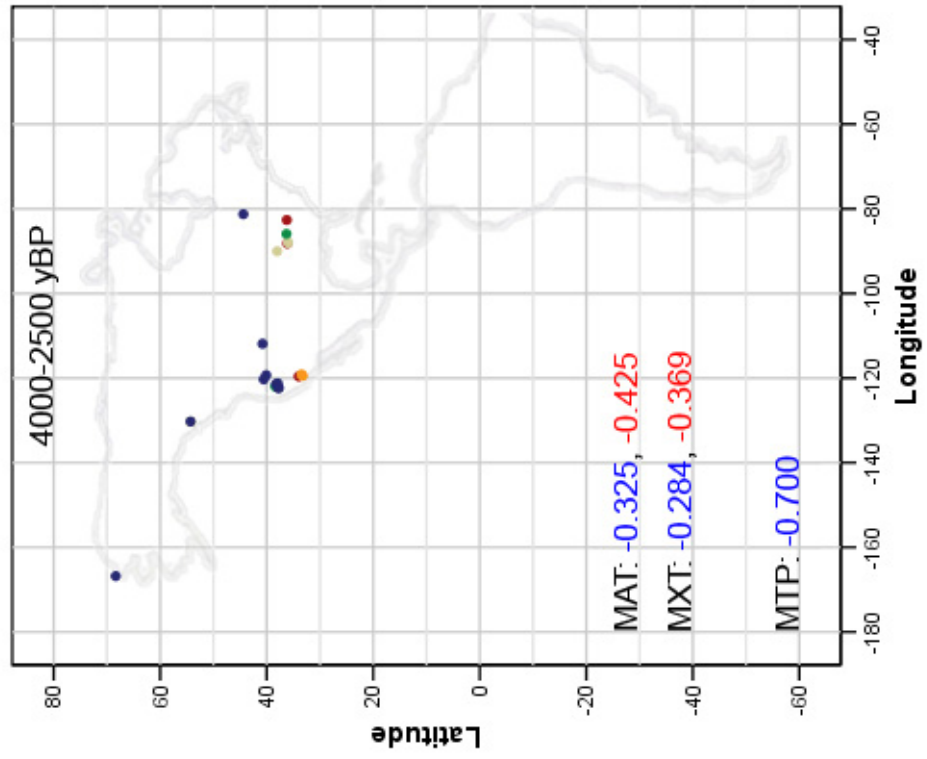


Figure A6.6.6. Female body mass (FHD BME)

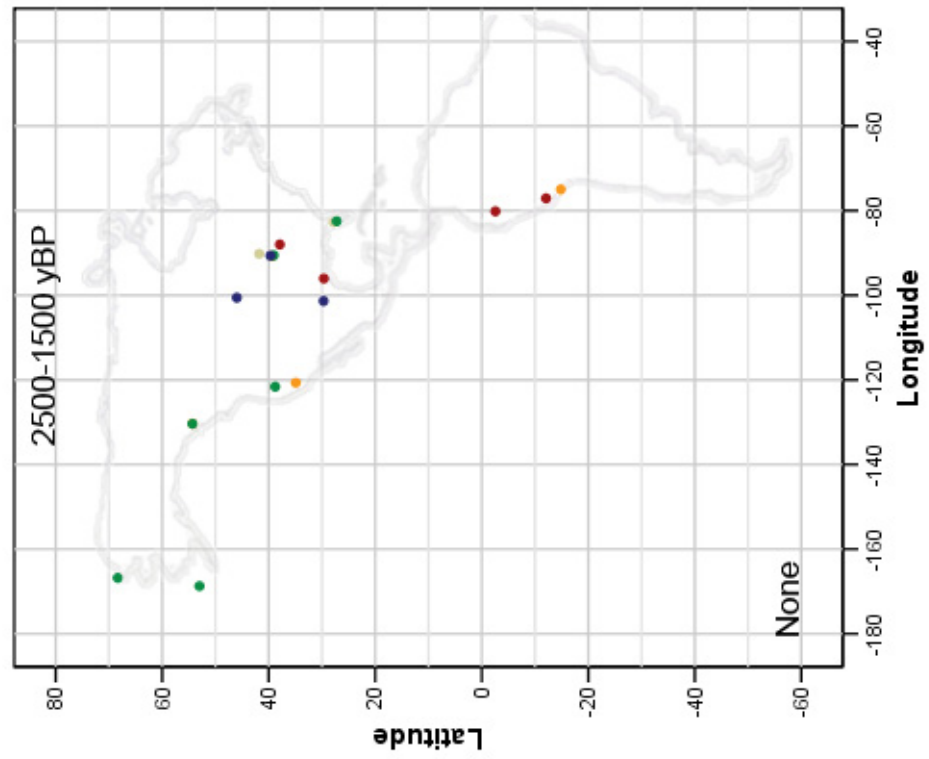
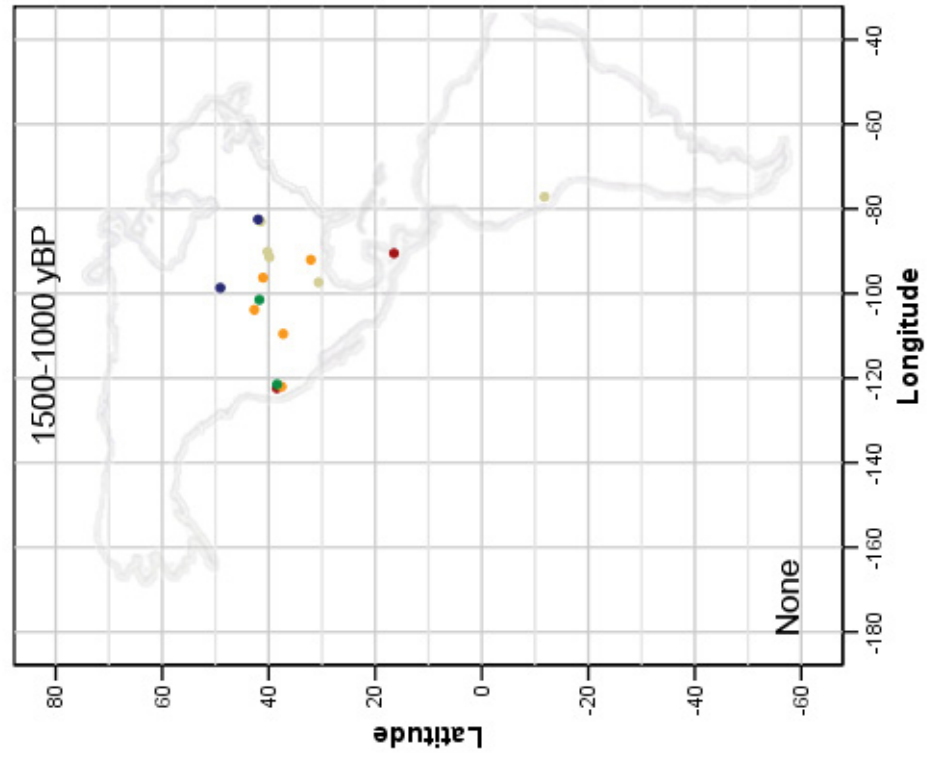


Figure A6.6.7. Female body mass (FHD BME)

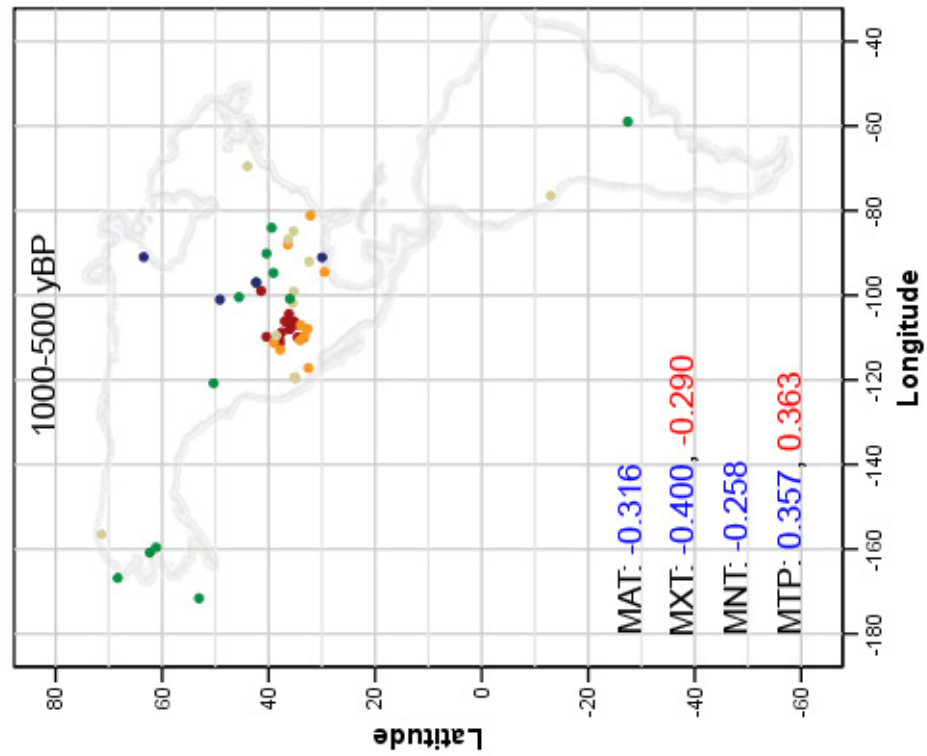
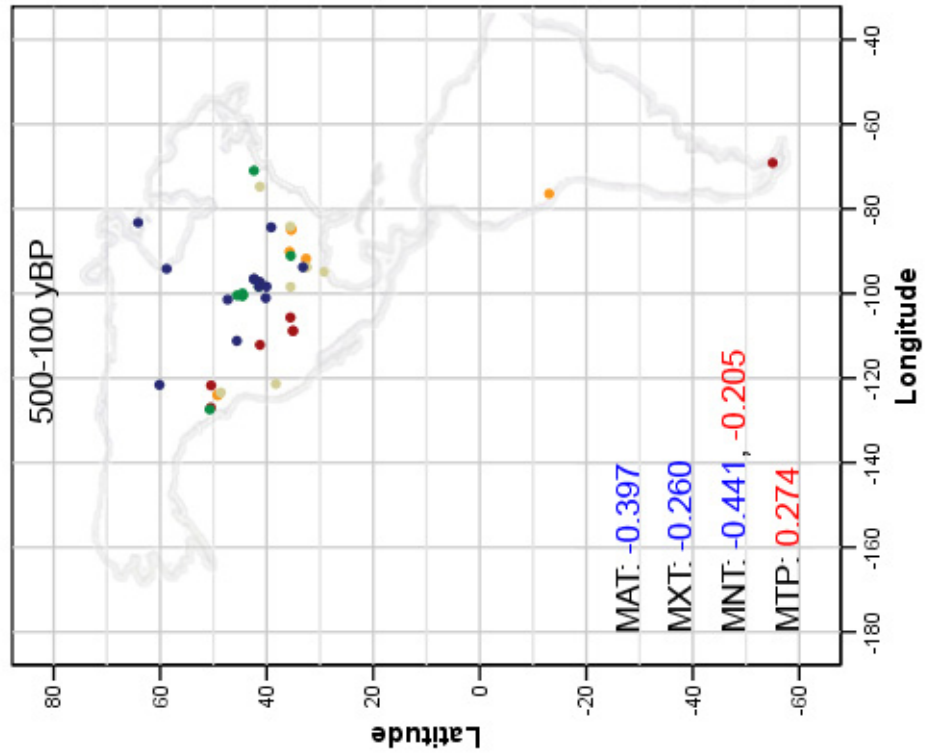


Figure A6.7.1. Stature (Fully Technique), all time periods, all samples

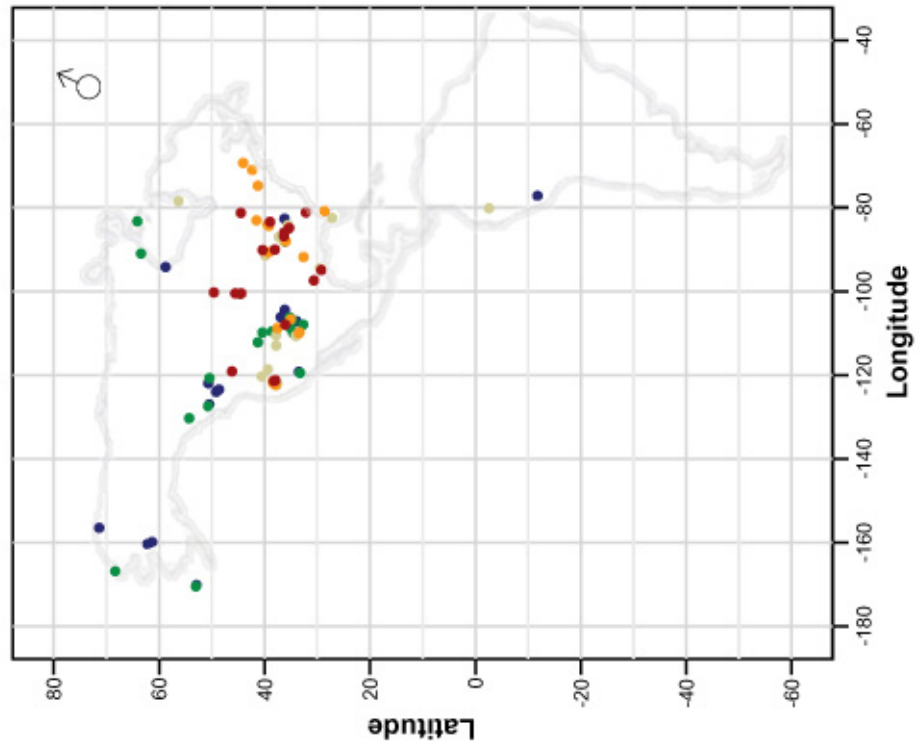
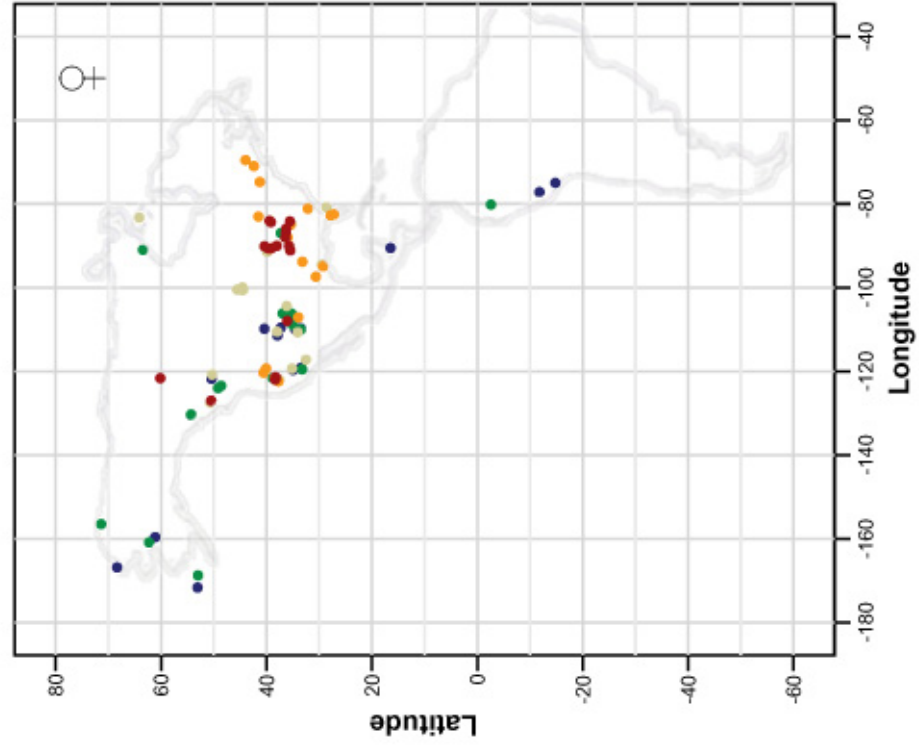


Figure A6.7.2. Male stature (Fully Technique)

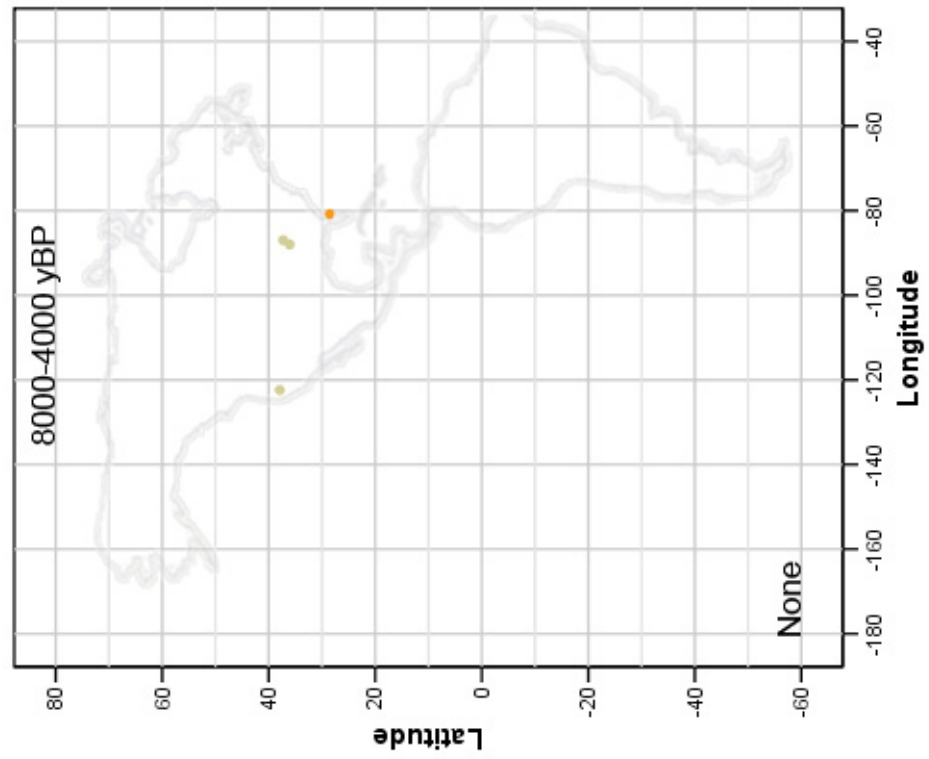
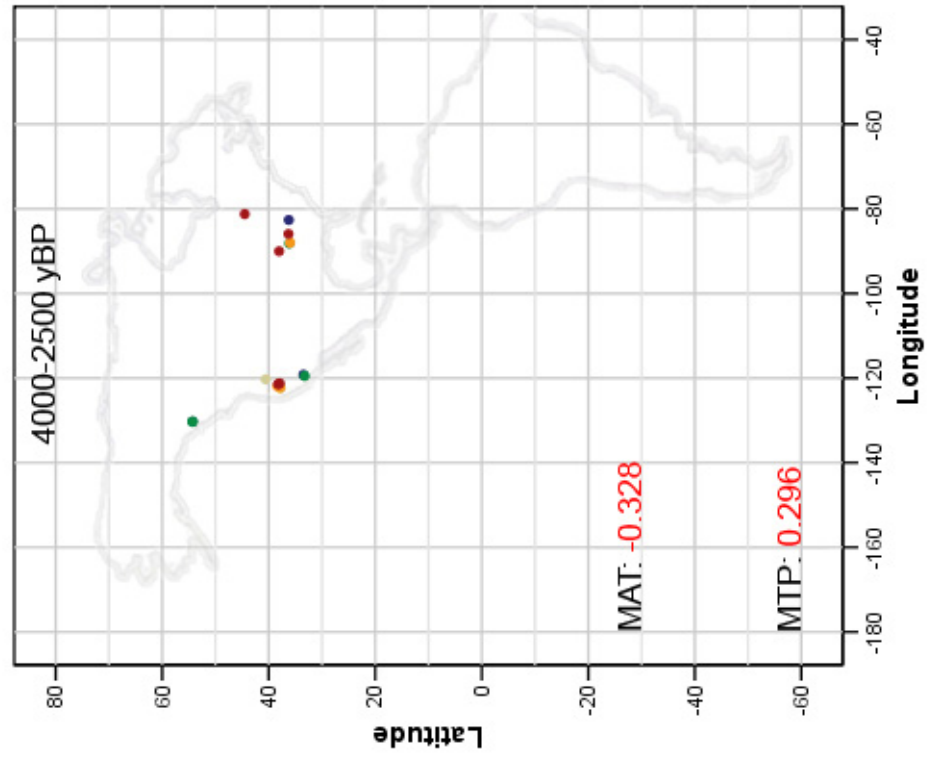


Figure A6.7.3. Male stature (Fully Technique)

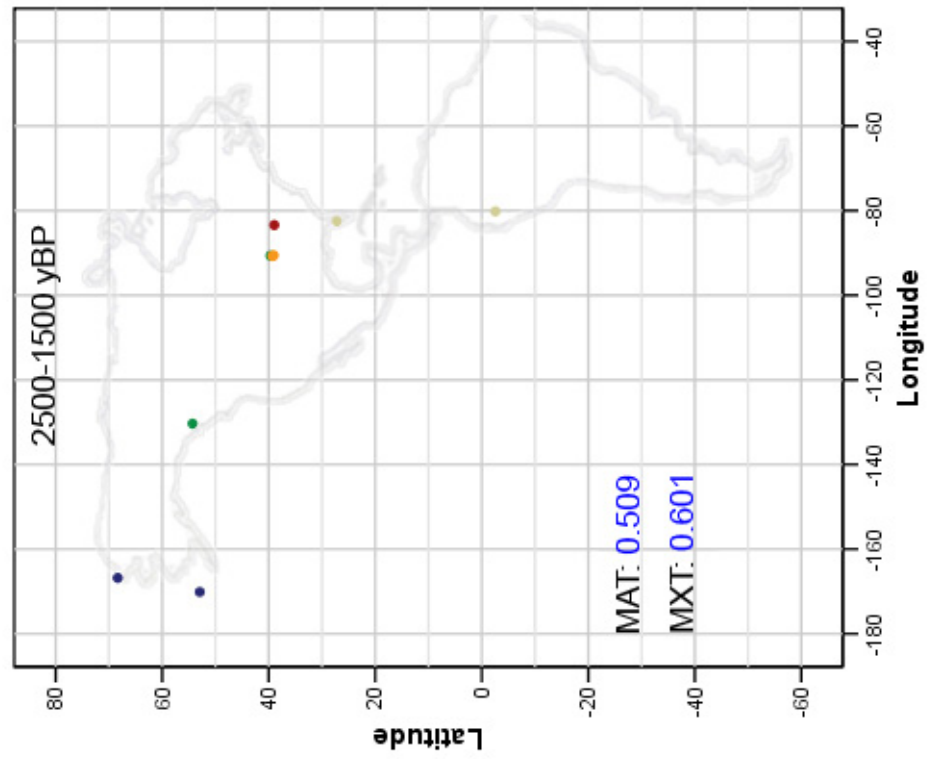
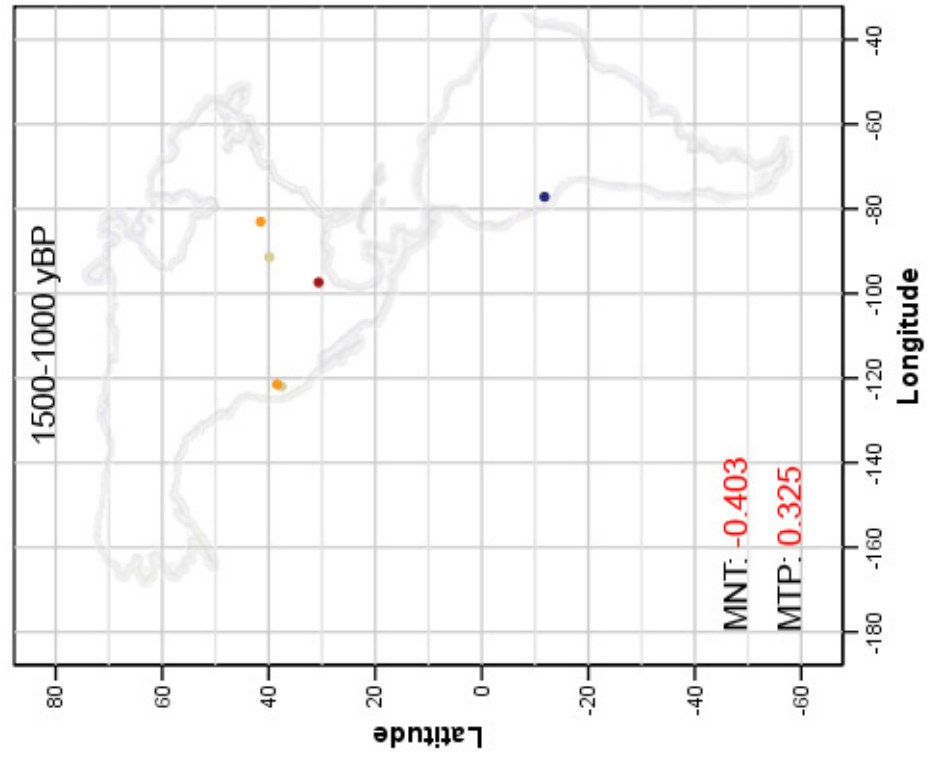


Figure A6.7.4. Male stature (Fully Technique)

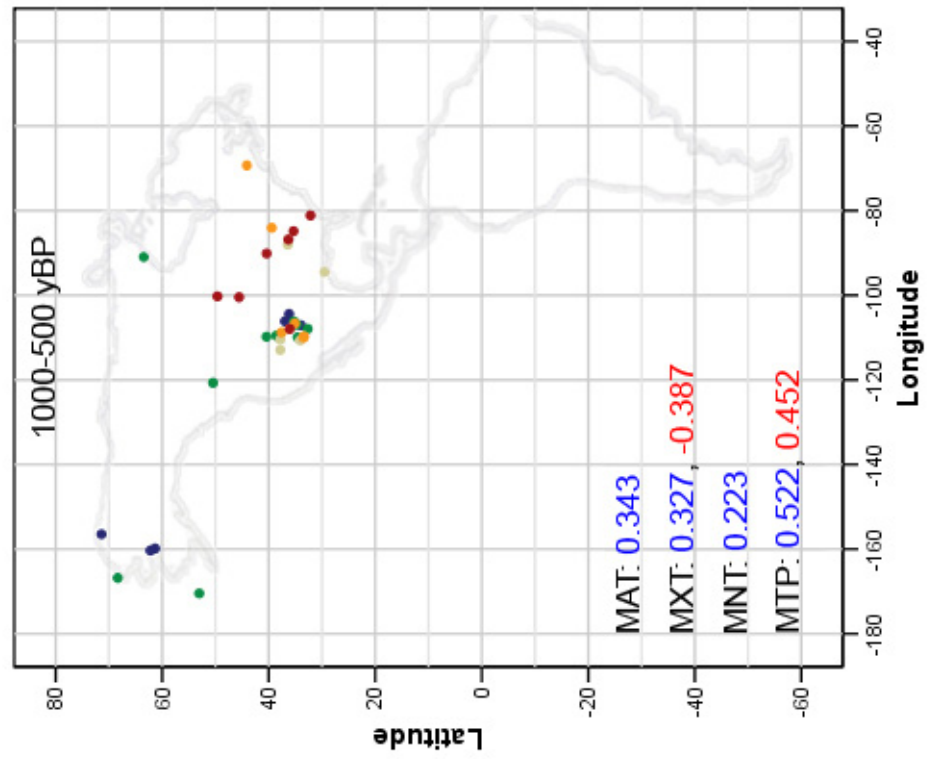
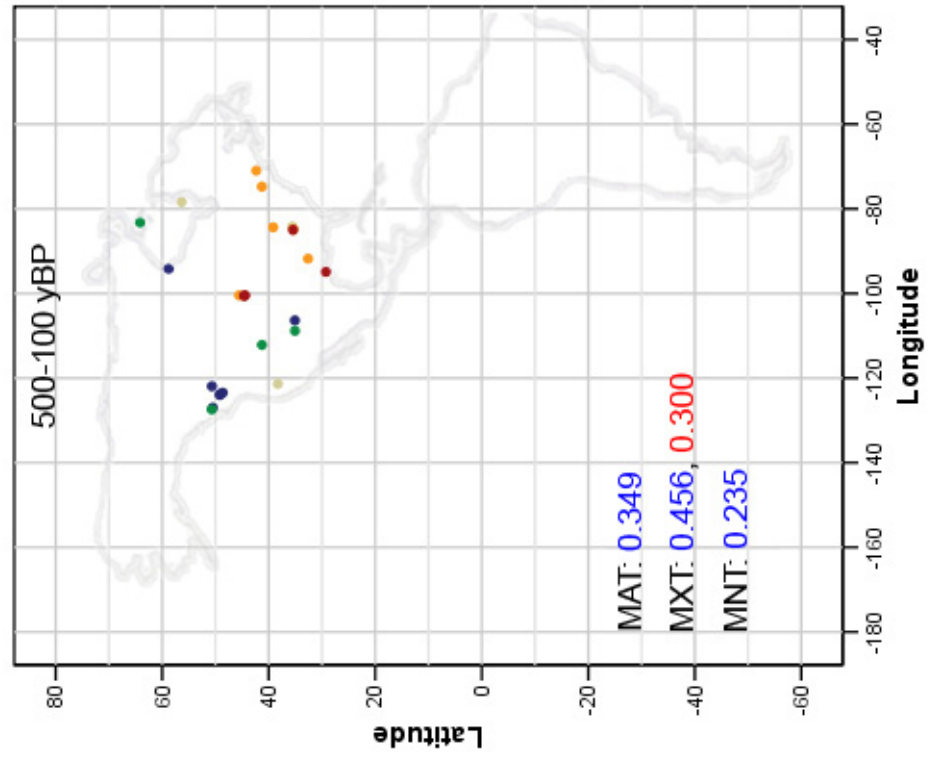


Figure A6.7.5. Female stature (Fully Technique)

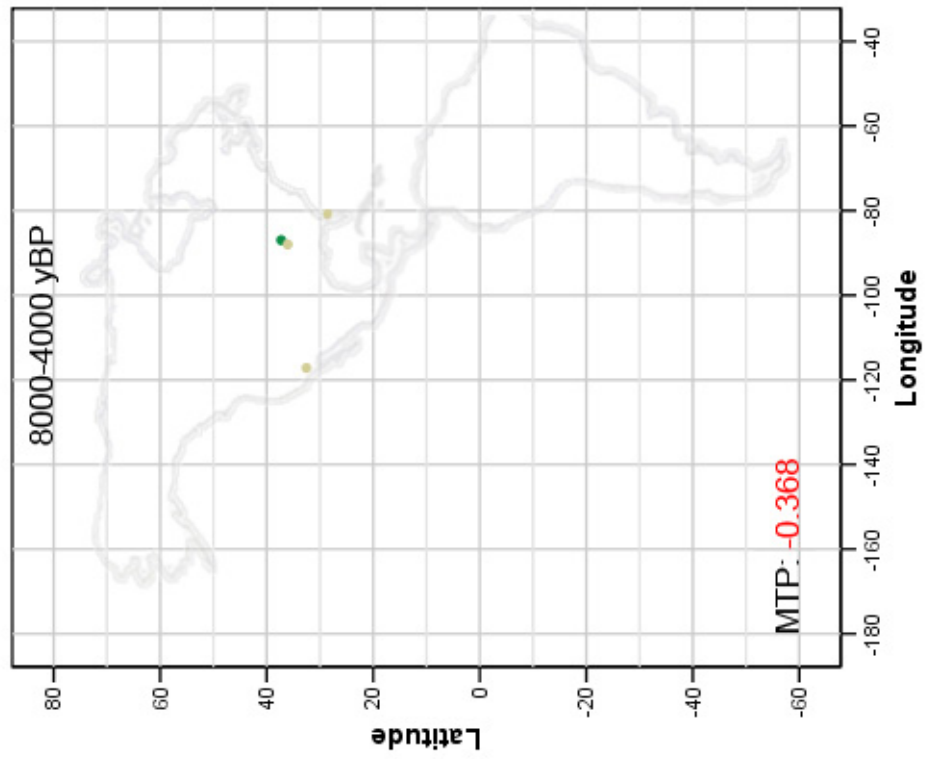
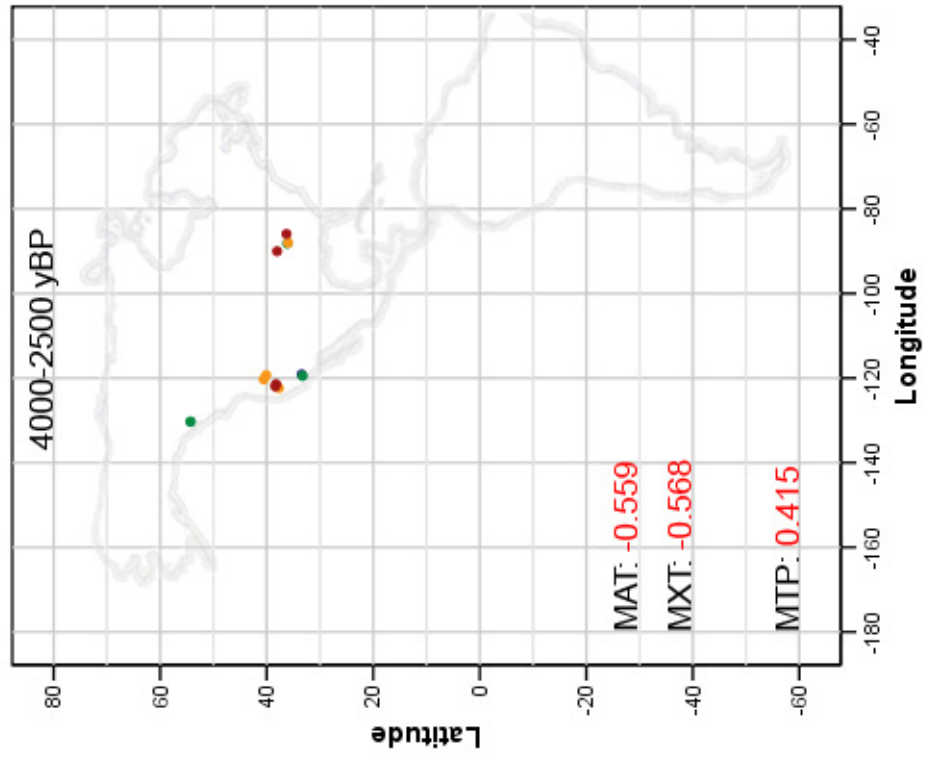


Figure A6.7.6. Female stature (Fully Technique)

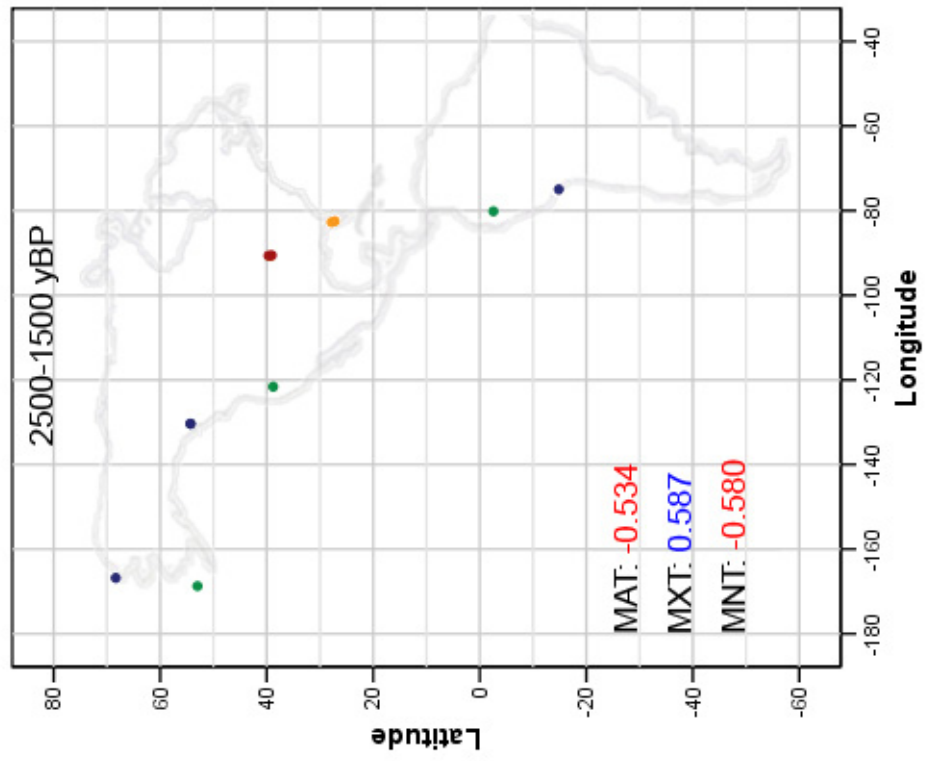
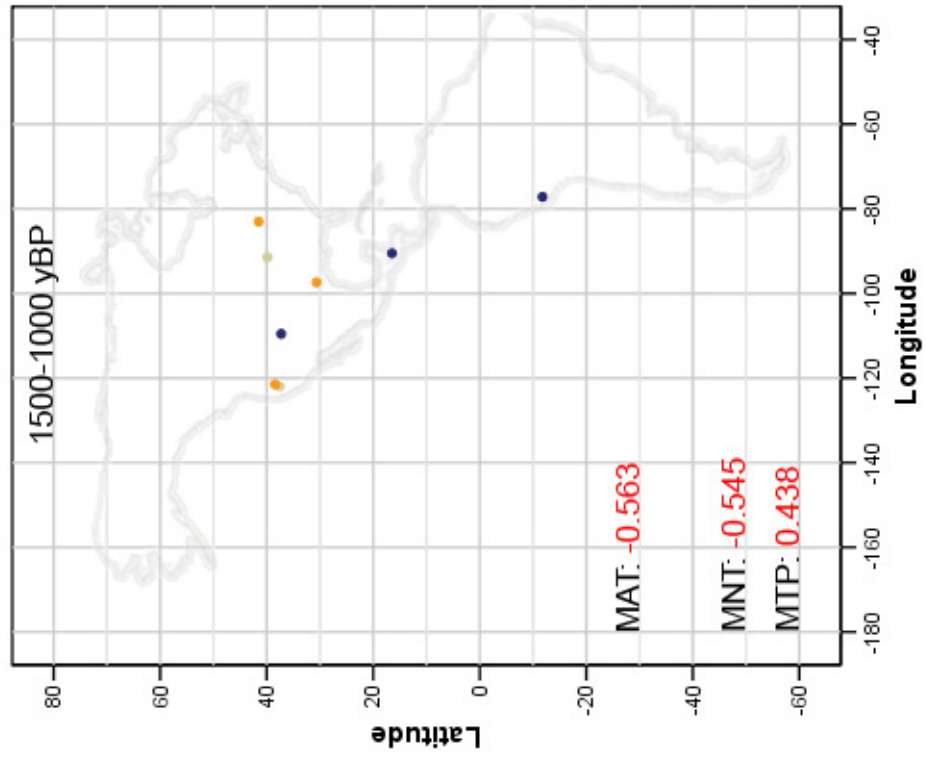
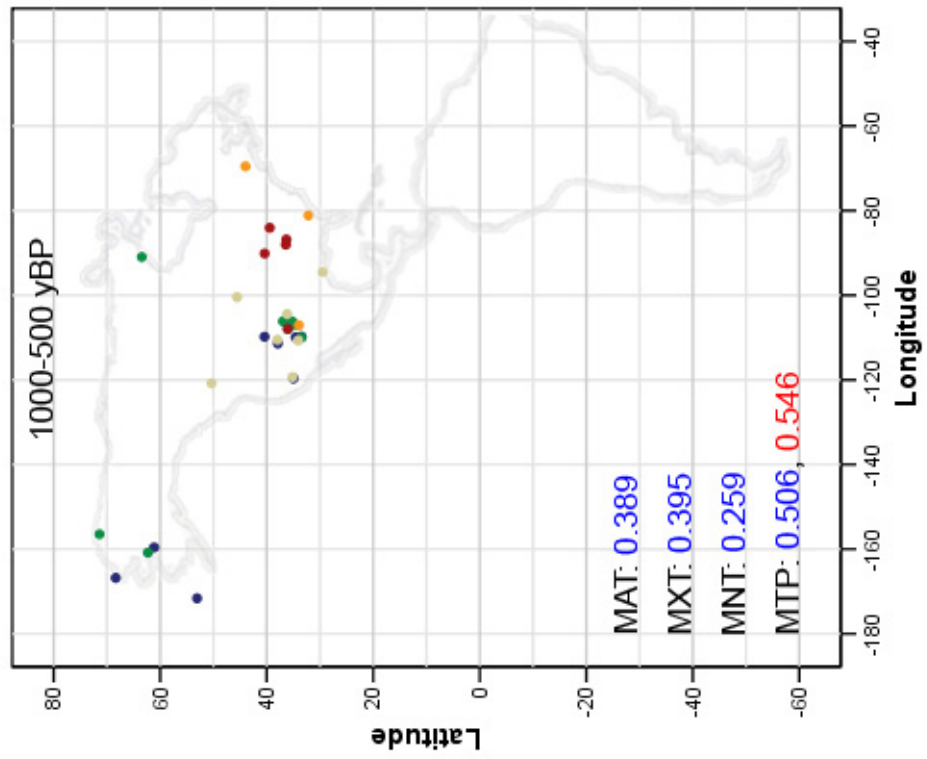
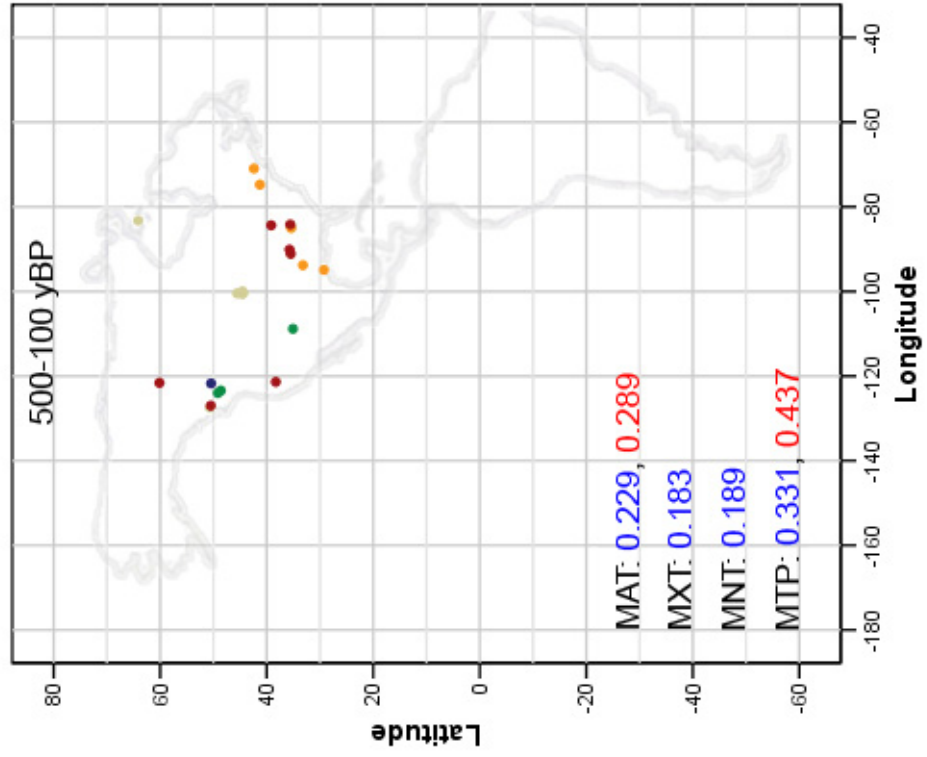


Figure A6.7.7. Female stature (Fully Technique)



Appendix VII. Mean and median directional (%DA) and absolute (%AA) asymmetries for all limb dimensions, by subsistence group and sex. Dimension abbreviations are the same as those used in Appendix II.

MALES: Mean %DA

Subsistence group	CML	CAD	HML	HEB	HHD	HAD	HDA	RML	RAD	RAHD	RDA	UML	UAD
ALL	-1.21	3.04	0.87	1.46	1.12	4.16	0.69	0.58	2.35	1.19	1.28	0.51	2.61
BSHG	-0.59	10.71	0.45	1.64	0.90	8.01	0.58	0.80	3.06	-0.52	3.50	0.56	2.50
FHG	-1.75	4.09	0.84	1.54	0.94	4.63	1.17	0.38	1.98	1.04	1.20	0.46	2.55
MHG	-1.41	2.77	1.32	1.27	1.23	3.86	0.83	0.49	2.11	1.56	1.59	0.30	3.44
IH	-1.56	2.91	0.64	1.23	0.92	3.85	0.62	0.59	2.23	0.61	1.44	0.60	1.96
VHH	0.26	4.80	1.86	2.26	1.69	4.87	0.04	0.80	2.21	1.90	2.58	0.72	3.89
AGR	-0.89	2.13	0.54	1.50	1.14	4.02	0.47	0.70	2.74	1.19	0.80	0.61	2.12

Subsistence group	FML	FEB	FAB	FHD	FAD	TML	TPB	TPA	TAD	TDA	FIML
ALL	-0.30	0.37	0.31	0.16	-0.65	0.01	0.14	0.44	2.26	-0.98	-0.03
BSHG	-0.30	-0.66	0.75	0.37	0.90	-0.43	-0.07	1.07	3.14	3.46	-0.65
FHG	-0.34	0.40	0.50	-0.01	-0.65	0.05	0.34	0.77	2.09	-1.22	-0.08
MHG	-0.08	0.39	0.37	0.46	-1.07	0.13	0.45	0.71	2.23	-0.39	0.05
IH	-0.29	0.28	0.31	0.15	-0.35	-0.15	-0.24	0.10	2.24	-0.16	-0.20
VHH	-0.41	0.59	0.36	0.31	-0.68	0.15	0.47	0.66	1.43	0.02	0.65
AGR	-0.39	0.37	0.15	0.05	-0.55	-0.04	-0.03	0.18	2.50	-1.80	-0.17

FEMALES: Mean %DA

Subsistence group	CML	CAD	HML	HEB	HHD	HAD	HDA	RML	RAD	RAHD	RDA	UML	UAD
ALL	-1.46	2.26	1.45	1.42	0.39	2.50	0.48	1.02	1.91	0.98	1.09	0.85	2.43
BSHG	-0.40	0.58	0.70	1.67	0.76	0.46	0.05	1.41	-1.71	-0.40	0.95	1.36	-3.51
FHG	-1.23	2.46	1.35	1.31	0.60	3.18	0.73	0.93	1.14	0.69	2.08	0.78	3.51
MHG	-1.70	1.91	1.63	1.65	0.41	2.71	1.17	0.72	2.09	0.63	1.22	0.56	3.25
IH	-1.52	2.94	1.32	0.32	0.21	1.94	0.08	1.02	0.48	0.17	1.08	0.79	1.77
VHH	-1.86	2.94	2.14	0.98	0.08	2.87	-1.08	1.19	2.23	1.82	1.55	1.25	1.75
AGR	-1.37	2.13	1.37	1.65	0.36	2.27	0.36	1.16	2.51	1.39	0.57	0.97	1.95

Subsistence group	FML	FEB	FAB	FHD	FAD	TML	TPB	TPA	TAD	TDA	FIML
ALL	-0.26	0.25	0.25	0.20	-0.86	0.02	0.22	0.42	1.99	-1.15	0.00
BSHG	-0.45	0.92	1.99	1.41	-1.66	-0.41	-0.56	1.20	1.04	-0.29	
FHG	-0.35	0.33	0.17	0.11	0.03	-0.07	0.32	0.42	1.94	-0.44	-0.05
MHG	-0.09	0.19	0.53	0.48	-0.98	0.07	0.42	0.62	1.59	-1.05	0.01
IH	-0.23	0.55	0.40	0.29	-0.98	0.04	0.10	0.39	2.18	-0.51	0.64
VHH	-0.24	-0.15	-0.37	0.15	-2.02	-0.10	-0.35	-0.36	0.73	-2.38	0.04
AGR	-0.30	0.21	0.16	0.07	-0.95	0.04	0.21	0.43	2.33	-1.49	-0.16

MALES: Median %DA

Subsistence group	CML	CAD	HML	HEB	HHD	HAD	HDA	RML	RAD	RAHD	RDA	UML	UAD
ALL	-1.35	3.04	0.90	1.65	1.21	4.19	0.67	0.66	2.54	1.23	1.16	0.61	2.65
BSHG	-0.69	12.22	0.31	1.61	1.79	7.81	0.88	0.78	3.33	-0.35	1.47	1.06	2.60
FHG	-1.85	3.79	0.94	1.71	1.08	4.86	1.07	0.41	2.00	1.22	0.82	0.56	2.66
MHG	-1.43	2.75	1.37	1.55	1.34	4.05	0.91	0.58	2.51	1.32	1.88	0.40	3.43
IH	-1.63	3.16	0.77	1.63	0.87	3.60	0.87	0.78	2.14	1.09	1.30	0.72	1.70
VHH	0.64	6.32	1.78	2.43	1.77	5.74	-0.33	0.98	2.29	2.41	2.03	0.75	3.24
AGR	-1.28	2.23	0.59	1.65	1.30	3.93	0.28	0.79	2.82	1.12	0.76	0.72	1.96

Subsistence group	FML	FEB	FAB	FHD	FAD	TML	TPB	TPA	TAD	TDA	FIML
ALL	-0.34	0.62	0.20	0.11	-0.52	-0.12	0.63	0.37	2.08	-0.92	-0.14
BSHG	-0.32	0.31	0.75	0.52	0.09	-0.26	-0.03	0.46	2.77	1.61	-0.68
FHG	-0.35	0.64	0.15	-0.02	-0.40	-0.13	0.66	0.51	1.73	-0.95	-0.14
MHG	-0.12	0.60	0.35	0.45	-0.51	0.14	0.68	0.58	1.79	-0.45	0.15
IH	-0.32	0.60	0.06	-0.09	-0.50	-0.26	-0.62	0.30	2.60	-0.12	-0.27
VHH	-0.47	0.61	0.22	0.43	-0.53	0.14	0.65	0.65	1.34	0.34	0.25
AGR	-0.38	0.62	0.20	0.06	-0.63	0.12	-0.63	0.15	2.50	-2.02	-0.26

FEMALES: Median %DA

Subsistence group	CML	CAD	HML	HEB	HHD	HAD	HDA	RML	RAD	RAHD	RDA	UML	UAD
ALL	-1.54	2.16	1.39	1.80	0.47	2.50	0.46	1.01	1.96	1.05	1.19	0.84	2.24
BSHG	-0.90	1.35	0.67	1.90	1.72	0.67	0.17	0.91	-0.64	-0.02	2.45	1.28	-5.36
FHG	-1.48	2.28	1.34	1.90	0.65	3.26	0.55	0.95	1.52	0.77	2.22	0.85	4.03
MHG	-1.84	1.92	1.64	1.77	0.53	2.77	1.17	0.91	2.09	0.91	1.31	0.72	2.84
IH	-1.49	2.40	1.24	0.92	0.25	2.28	0.37	1.02	0.65	0.48	1.36	0.80	1.20
VHH	-1.90	1.95	2.16	1.75	0.52	2.66	-0.60	1.10	2.29	1.83	1.89	0.94	1.08
AGR	-1.52	2.17	1.33	1.83	0.32	2.27	0.24	1.03	2.57	1.56	0.64	0.86	1.93

Subsistence group	FML	FEB	FAB	FHD	FAD	TML	TPB	TPA	TAD	TDA	FIML
ALL	-0.27	0.68	0.23	0.17	-0.49	-0.15	0.72	0.55	1.79	-1.08	-0.16
BSHG	-0.48	1.10	1.30	1.15	-0.06	-0.42	-0.33	1.15	0.63	1.38	
FHG	-0.39	0.70	0.07	0.08	0.30	-0.15	0.77	0.75	1.86	-0.71	-0.31
MHG	-0.22	0.68	0.55	0.33	0.00	0.00	0.73	0.73	1.26	-0.62	-0.15
IH	-0.30	0.69	0.48	0.52	-1.22	0.14	0.70	0.36	1.73	-0.98	0.30
VHH	-0.24	-0.70	-0.60	0.07	-1.88	-0.29	-0.74	-0.33	0.83	-1.71	0.30
AGR	-0.34	0.67	0.22	0.08	-0.66	-0.15	0.73	0.54	2.22	-1.30	-0.30

MALES: Mean %AA

Subsistence group	CML	CAD	HML	HEB	HHD	HAD	HDA	RML	RAD	RAHD	RDA	UML	UAD
ALL	2.29	5.37	1.28	2.51	2.29	4.97	2.49	1.11	3.98	3.10	3.29	1.07	4.85
BSHG	1.55	10.71	0.73	2.60	2.74	8.01	1.03	0.95	4.14	2.98	3.60	1.17	4.22
FHG	2.62	5.72	1.28	2.62	2.21	5.55	2.66	1.06	4.05	2.94	3.15	1.10	4.96
MHG	2.44	4.97	1.60	2.40	2.32	4.68	2.60	1.14	3.91	3.26	3.53	0.97	5.19
IH	2.25	5.50	1.13	2.41	2.27	4.57	2.54	1.09	3.67	2.88	3.43	1.13	4.66
VHH	2.16	6.54	1.98	2.85	2.49	6.02	2.22	1.20	3.62	3.35	3.11	1.20	4.85
AGR	2.05	5.03	1.02	2.51	2.27	4.78	2.39	1.13	4.15	3.14	3.21	1.06	4.66

Subsistence group	FML	FEB	FAB	FHD	FAD	TML	TPB	TPA	TAD	TDA	FIML
ALL	0.77	1.66	1.87	1.35	2.64	0.75	1.84	1.74	3.90	4.50	0.88
BSHG	0.57	2.50	2.02	0.85	2.96	0.68	1.55	1.36	3.69	4.41	0.82
FHG	0.78	1.74	2.20	1.22	2.76	0.73	1.82	2.10	3.82	4.40	0.78
MHG	0.75	1.63	1.86	1.44	2.65	0.79	1.97	1.98	3.61	4.47	0.91
IH	0.72	1.78	1.90	1.20	2.20	0.65	1.76	1.63	3.77	3.85	0.86
VHH	0.81	1.44	1.62	1.41	1.90	0.68	1.50	1.39	3.41	4.11	1.36
AGR	0.78	1.60	1.73	1.41	2.80	0.79	1.85	1.52	4.24	4.85	0.79

FEMALES: Mean %AA

Subsistence group	CML	CAD	HML	HEB	HHD	HAD	HDA	RML	RAD	RAHD	RDA	UML	UAD
ALL	2.31	4.81	1.58	2.62	1.98	3.77	2.42	1.34	3.92	2.89	3.27	1.22	4.70
BSHG	2.37	8.09	1.07	2.23	1.87	3.36	1.15	1.41	2.72	2.61	3.39	1.36	6.80
FHG	2.26	4.47	1.57	2.71	1.94	4.75	2.31	1.44	3.78	3.05	3.94	1.30	4.93
MHG	2.33	4.40	1.73	2.75	2.16	3.77	2.67	1.33	3.54	2.84	3.17	1.06	5.30
IH	2.06	5.00	1.50	2.70	1.95	3.52	2.08	1.20	2.99	2.63	3.27	1.09	3.94
VHH	2.76	5.03	2.14	2.30	2.10	3.89	2.44	1.34	3.19	2.66	3.15	1.38	4.49
AGR	2.31	5.00	1.48	2.56	1.90	3.43	2.47	1.33	4.52	2.95	3.07	1.28	4.48

Subsistence group	FML	FEB	FAB	FHD	FAD	TML	TPB	TPA	TAD	TDA	FIML
ALL	0.76	1.68	1.93	1.39	2.79	0.72	1.89	1.82	3.73	4.58	0.84
BSHG	0.65	1.26	2.94	1.43	2.31	0.41	1.67	2.18	2.05	6.52	
FHG	0.79	1.55	1.85	1.26	2.50	0.72	2.04	1.89	3.12	4.25	0.88
MHG	0.74	1.85	2.17	1.68	3.05	0.71	1.80	1.92	2.91	3.89	0.83
IH	0.77	1.52	1.65	1.38	2.73	0.75	1.74	1.68	3.75	4.05	1.30
VHH	0.79	1.89	2.08	1.36	2.95	0.84	1.81	1.51	3.35	4.56	0.84
AGR	0.75	1.68	1.87	1.33	2.79	0.69	1.93	1.81	4.40	5.13	0.71

MALES: Median %AA

Subsistence group	CML	CAD	HML	HEB	HHD	HAD	HDA	RML	RAD	RAHD	RDA	UML	UAD
ALL	1.97	4.33	1.12	1.77	1.95	4.45	1.96	0.91	3.32	2.57	2.59	0.84	4.00
BSHG	1.22	12.22	0.48	1.64	2.45	7.81	1.01	0.78	3.49	3.39	1.47	1.13	4.37
FHG	2.21	4.89	1.22	1.83	1.85	5.02	2.24	0.86	3.56	2.21	2.61	0.96	4.13
MHG	2.02	3.76	1.47	1.71	2.01	4.28	2.16	0.85	3.32	2.79	3.04	0.80	4.69
IH	2.02	4.89	0.92	1.71	1.98	3.81	1.89	0.88	3.12	2.43	2.74	0.91	4.35
VHH	1.61	6.46	1.83	2.49	1.87	6.02	1.74	1.13	3.02	3.14	2.32	0.99	3.93
AGR	1.87	4.05	0.82	1.75	1.92	4.33	1.77	0.95	3.38	2.66	2.41	0.83	3.84

Subsistence group	FML	FEB	FAB	FHD	FAD	TML	TPB	TPA	TAD	TDA	FIML
ALL	0.63	1.26	1.44	1.07	1.89	0.57	1.36	1.36	3.16	3.64	0.62
BSHG	0.47	1.56	1.27	0.81	3.69	0.43	1.56	0.93	2.77	2.29	0.68
FHG	0.59	1.26	1.76	1.03	1.82	0.57	1.36	1.71	3.05	3.41	0.60
MHG	0.66	1.21	1.58	1.11	1.74	0.60	1.38	1.45	2.70	3.83	0.64
IH	0.56	1.27	1.38	0.88	1.84	0.54	1.34	1.27	3.49	3.17	0.78
VHH	0.66	1.21	1.17	1.17	1.64	0.54	1.24	1.22	2.63	3.02	0.65
AGR	0.65	1.27	1.34	1.12	2.20	0.62	1.38	1.18	3.43	4.07	0.59

FEMALES: Median %AA

Subsistence group	CML	CAD	HML	HEB	HHD	HAD	HDA	RML	RAD	RAHD	RDA	UML	UAD
ALL	2.00	3.69	1.44	1.96	1.56	3.14	1.99	1.10	3.27	2.26	2.57	0.97	3.83
BSHG	2.02	6.92	0.68	2.51	2.11	3.40	1.00	0.91	1.59	0.87	3.84	1.28	7.72
FHG	1.89	3.82	1.44	2.69	1.47	3.94	1.77	1.19	3.27	2.39	3.64	1.03	4.28
MHG	2.11	3.69	1.67	2.00	1.62	3.21	2.11	1.14	2.95	2.38	2.32	0.88	4.21
IH	1.65	3.87	1.35	1.90	1.56	3.12	1.84	1.04	1.75	2.12	3.05	0.82	2.99
VHH	2.68	3.96	2.16	1.94	1.65	3.05	2.07	1.16	2.60	1.95	2.89	1.01	3.36
AGR	2.02	3.61	1.36	1.94	1.47	2.80	2.08	1.07	3.89	2.28	2.36	1.04	3.68

Subsistence group	FML	FEB	FAB	FHD	FAD	TML	TPB	TPA	TAD	TDA	FIML
ALL	0.66	1.40	1.54	1.02	1.94	0.58	1.50	1.44	2.92	3.72	0.63
BSHG	0.55	1.10	2.29	1.15	0.94	0.42	1.44	1.74	1.70	6.21	
FHG	0.71	1.39	1.55	0.94	1.82	0.53	1.53	1.49	2.61	3.28	0.79
MHG	0.66	1.42	1.87	1.17	1.68	0.59	1.48	1.68	2.06	3.01	0.87
IH	0.61	1.36	1.39	1.08	2.20	0.60	1.45	1.37	3.06	3.24	0.77
VHH	0.63	1.35	1.69	0.86	2.27	0.68	1.44	1.03	2.51	3.94	0.74
AGR	0.67	1.41	1.47	1.01	2.06	0.58	1.52	1.42	3.46	4.28	0.58

Curriculum Vitae: Benjamin Miller Auerbach

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Education:

Ph.D., Functional Anatomy and Evolution (2007)

Center for Functional Anatomy & Evolution, Johns Hopkins University School of Medicine,
Baltimore, MD

Dissertation: "Human skeletal variation in the New World during the Holocene: effects of climate and subsistence across geography and time" (Advisor: Christopher B. Ruff)

Research Fellowship, Biological Anthropology (2001-2002)

Miami University, Joanna Jackson Goldman Memorial Prize (Supervisor: William C. McGrew)

B.A., Anthropology (with a minor in Criminology) (2001)

Miami University, Oxford, OH

Departmental Honors Thesis: "Regional Population Variation in Turn-of-the-Century Crete"
(Advisors: Marta M. Lahr and Linda F. Marchant)

B.A., Comparative Religion (2001)

Miami University, Oxford, OH

Departmental and University Honors Thesis: "Mind, Body, and Soul: Ideas About Disease as Explained by Theravada Buddhist Writers and Maimonides" (Advisor: Aaron Hughes)

Research Interests:

Modern human morphological variation; multi-disciplinary analysis of the skeleton; ecogeographic variation in body size and proportions; estimation of stature and body mass in human ancestors; New World population history; climatic and subsistence effects on morphology; disease and human evolution; evolutionary theory; population genetics; clinal population modeling

Research Support, Fellowships, and Awards:

National Science Foundation Dissertation Improvement Grant (awarded 2006, active 2006-2007)

"Human skeletal variation in the prehistoric New World: geographic, temporal and climatic effects" (NSF #0550673)

Co-Investigator with Dr. Christopher Ruff (PI)

Johns Hopkins University Graduate Student Stipend (awarded 2002; active 2005-2007)

National Science Foundation Graduate Research Fellowship (awarded 2001, active 2002-2005)

Academic grant awarded nationally to students pursuing a specific graduate (doctoral) program, funding three years of study in a five-year period.

Joanna Jackson Goldman Memorial Prize (awarded 2001, active 2001-2002)

\$23,300 academic award given to one graduating student from Miami University each year to fund independent research or creative activities. It was used to fund a research fellowship in which osteological measurements from over 1300 skeletons from Old and New World populations were obtained from collections in Europe and North America (see Auerbach & Ruff, 2005; 2004).

Anthropology Departmental Award for Excellence in Research, Miami University (2001)

Newell S. Booth Award for Outstanding Student in the Study of Religion, Miami University
(2001)

Miami University Undergraduate Summer Scholars (awarded 2000)

Academic grant awarded at Miami University to 100 students each year, used to fund research on while studying at the University of Cambridge, Department of Biological Anthropology.

Miami University Scholar-Leader Program Raymond E. Glos Scholarship (1999-2000)

Miami University Harrison Scholar (1997-2001; full-tuition scholarship)

Current and Previous Positions:

Web Master and Designer, Center for Functional Anatomy & Evolution, Johns Hopkins University School of Medicine (2004-present)

Instructor, Department of Anthropology, University of Maryland, College Park (summer 2004).

Site Skeletal Biologist, Kentucky Archaeological Survey (April 2002).

Archaeological site skeletal biologist for first weeks of salvage excavation of 19th century Old Frankfort Cemetery, Frankfort, Kentucky.

Research and Laboratory Assistant, Drs. William McGrew and Linda Marchant, Miami University (1998-2001). Lab assistant and librarian in the Miami University Biological Anthropology Lab.

Operations included data analysis, computer cataloguing of reprints, correspondence, filing, clerical work, and student and faculty assistance in using lab resources.

Teaching Experience:

Laboratory instructor, *Human Gross Anatomy* (2004-2006)

Johns Hopkins University School of Medicine (medical and graduate students)

Co-instructor and course director, *Human Osteology* (2004)

Department of Anthropology, University of Maryland, College Park, MD (undergraduate students)

Laboratory instructor, *Summer Institute in Anatomy* (2003-2004)

Johns Hopkins University School of Medicine (undergraduate students)

Peer-Reviewed Publications:

Auerbach BM, & Ruff CB. 2006. Limb bone bilateral asymmetry: variability and commonality among modern humans. *Journal of Human Evolution* 50:203-218.*

Raxter MH, **Auerbach BM**, & Ruff CB. 2006. Revision of the Fully Technique for estimating statures. *American Journal of Physical Anthropology* 130:374-384.*

Auerbach BM, & Ruff CB. 2004. Human body mass estimation: a comparison of “morphometric” and “mechanical” methods. *American Journal of Physical Anthropology* 125:331-342.*

Raxter MH, Ruff CB, & **Auerbach BM**. 2007. Technical Note: Use of revised Fully stature estimation technique. *American Journal of Physical Anthropology* 133:817-818.*

Auerbach BM & Raxter MH. in review. Patterns of clavicular bilateral asymmetry in relation to the humerus: variation among humans and evolutionary considerations. *Journal of Human Evolution*

Auerbach BM. in review. Body mass, stature, and proportions of the Kennewick early Holocene skeleton. Owsley, DW (ed.): *Untitled Kennewick Man monograph*.

Manuscripts in Preparation:

Temple D, Nakatsukasa M, & **Auerbach B**. A bioarchaeological perspective on health and behavior at Yoshigo Shell Mounds, a Late to Final Jomon site, Aichi Prefecture, Japan. (for submission to *Journal of Anthropological Science*)

Auerbach BM, Raxter MH, & Ruff CB. Estimation of missing elements and stature estimation accuracy using “anatomical” and “mathematical” methods for estimating stature. (for submission to *American Journal of Physical Anthropology*)

(Manuscripts in Preparation – continued)

DeLeon VB, & **Auerbach BM**. Morphological integration and variation in the human post-cranial skeleton. (for submission to *Evolution*)

Auerbach BM, Organ JM, & Rose KD. The biomechanics of ungual phalanges in relation to locomotor guilds. (for submission to *Journal of Vertebrate Paleontology*)

Peer-Reviewed Meeting Abstracts:

Auerbach BM, Organ JM, & Rose KD. 2007. Ungual phalanx biomechanics and locomotor behavior in extant and extinct mammals. *FASEB Journal*

Auerbach BM. 2007. Proportional patterns in prehistory: Cranial and post-cranial correspondence in body proportions among pre-contact Native Americans. Symposium: “Biological variation and evolutionary dynamics in ancient populations of the Americas” *American Journal of Physical Anthropology* S44:66. (*Competing for AAPA Student Prize)

DeLeon VB, & **Auerbach BM**. 2007. Morphological integration in human long bones. *American Journal of Physical Anthropology* S44:96.

Raxter MH, Ruff CB, Azab A, Erfan M, El-Sawaf A, **Auerbach BM**. 2007. New long bone stature estimation equations for ancient Egyptians. *American Journal of Physical Anthropology* S44:196.

Auerbach BM. 2006. One of these is not like the other? Skeletal variation in western Alaska Native Americans, climate, and population history. Invited symposium: “The Bioarchaeology of pre-contact Point Hope, Alaska.” *American Journal of Physical Anthropology* S42:59.

Raxter MH, **Auerbach BM**, & Barker K. 2006. Patterns of clavicular asymmetry in relation to humeral asymmetry in humans and great apes. *American Journal of Physical Anthropology* S42:152.

Auerbach BM, Raxter MH, & Ruff CB. 2005. If I only had a...: missing element estimation accuracy using the Fully Technique for estimating statures. *American Journal of Physical Anthropology* S40:70.

Raxter MH, **Auerbach BM**, & Ruff CB. 2005. A test of Fully’s stature reconstruction technique in Terry Collection whites and blacks. *American Journal of Physical Anthropology* S40:172-173.

Auerbach BM, & Ruff CB. 2004. The right preferences? Bilateral asymmetry in the upper and lower limbs of modern humans. *American Journal of Physical Anthropology* S38:56.

Auerbach BM, & Ruff CB. 2003. Mass matters: An evaluation of two body mass estimation techniques in modern human populations. *American Journal of Physical Anthropology* S36:61.

Auerbach BM, & Lahr MM. 2001. Variation in a pre-industrial population: occupation and stature in early Twentieth Century Crete. *American Journal of Physical Anthropology* S32:34.

Auerbach, Benjamin M. 1999. Survival Through Cultural Intervention: Two Adult, Fort Ancient Shawnee at 15GP15. *Kentucky Heritage Council Annual Meeting*

Chaired Symposia:

“Biological variation and evolutionary dynamics in ancient populations of the Americas,” *American Association of Physical Anthropologists Annual Meeting, Philadelphia, PA*. Co-organized with KJ Weinstein. March 2007.

Professional Activities:

Development and distribution of human osteological databases for using the revised Fully stature estimation technique (Raxter et al., 2006) and for estimating missing elements within technique (Auerbach et al., 2005).

Volunteer for archaeological excavation field crews in Illinois and Kentucky (1998-2002).

Professional Museum and Archaeological Experience:

Osteological data collection: American Museum of Natural History (New York, New York); Arizona State Museum (University of Arizona) (Tucson, Arizona); British Museum (The Natural History Museum) (London, England, United Kingdom); Burke Museum of Natural History and Culture (Kennewick Man) (Seattle, Washington); Canadian Museum of Civilization (Ottawa, Ontario, Canada); Cleveland Museum of Natural History (Cleveland, Ohio); Duckworth Osteological Collection (University of Cambridge) (Cambridge, England, United Kingdom); Field Museum (Chicago, Illinois); Florida Museum of Natural History (Gainesville, Florida); Florida State University (Tallahassee, Florida); Harvard Peabody Museum of Anthropology and Ethnology (Cambridge, Massachusetts); Illinois State Museum (Springfield, Illinois); Institut Royal des Sciences Naturelles de Belgique (Brussels, Belgium); Kent State University (Libben Collection) (Kent, Ohio); Kyoto University (Kyoto, Japan); Maxwell Museum of Anthropology (University of New Mexico) (Albuquerque, New Mexico); McClung Museum (University of Tennessee-Knoxville) (Knoxville, Tennessee); Musée de l'Homme (Paris, France); Museo Nazionale di Antropologia e Etnologia (Florence, Italy); National Museum of Natural History (Smithsonian, Washington, D.C.); Naturhistorisches Museum (Vienna, Austria); Nevada State Museum (Carson City, Nevada) (including Spirit Cave Man); Phoebe A. Hearst Museum of Anthropology (University of California-Berkeley) (Berkeley, California); San Diego Museum of Man (San Diego, California); San Jose State University (San Jose, California); Staatssammlung für Anthropologie und Palaeoanatomie (Munich, Germany); Texas Archaeological Research Laboratory (University of Texas-Austin) (Austin, Texas) (including Wilson-Leonard Woman); University of California-Davis (Davis, California); University of Missouri-Columbia (Columbia, Missouri); University of Oregon (Eugene, Oregon); University of Tennessee Anthropology Department (Knoxville, Tennessee); University of Utah (Salt Lake City, Utah); W.S. Webb Museum (Lexington, Kentucky)

Archaeological excavation: Daniel Boone National Forest (Rockcastle County, Kentucky); Moundhouse site (Greene County, Illinois); Old Frankfort Cemetery (Franklin County, Kentucky)

Professional Memberships:

2006- **American Association of Anatomists**, Student Member
2004- **Phi Beta Kappa**, Active Member
2001- **American Association for the Advancement of Science**, Member
1999- **American Association of Physical Anthropologists**, Member
2001-2003 **American Academy of Religion**, Member
2000-2003 **American Anthropological Association**, Student Member
1999- **Sigma Xi**, Member

Awards and Honoraries:

2001 Phi Beta Kappa
2001 Magna Cum Laude
2001 University Honors and Departmental Honors, Comparative Religion
2001 Departmental Honors, Anthropology
2001 Miami University Parents Association Community Service Award
2001 Miami University Dean's Certificate for Distinguished Student Achievement
1999 Golden Key National Honor Society
1997-2001 Dean's List / President's List, Miami University