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AFTER THE END: ANIMAL ECONOMIES, COLLAPSE, AND CONTINUITY IN  
HITTITE AND POST-HITTITE ANATOLIA

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This dissertation is dedicated to the memory of Shirley Norman.

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## ABSTRACT

This dissertation examines the processes involved in societal collapse and its aftermath. What does it mean to say a society has collapsed? Who is most affected, and how do they respond to changing circumstances? Is collapse ever final, and if not, what are the pieces that persist? This research contributes to the ongoing conversations surrounding these questions through the examination of on the ground responses to the Hittite collapse in central Anatolia (modern Turkey) around 1200 BC. The collapse of the Hittite empire was part of a massive regional collapse that affected much of the Eastern Mediterranean around the same time. In order to gain a better understanding of local responses to the breakdown of the imperial superstructure, my research includes the analysis and comparison of materials from both the Hittite capital, Hattuşa, and a rural center in the empire's provinces, Çadır Höyük. Conventional narratives of the Hittite collapse, and of collapse in the ancient world more broadly, often present collapse as a shift from centralized to decentralized forms of organization, assuming a degree of political and economic integration and interdependence such that when one aspect of the state's organizational structure (i.e. its political system) fails, its other organizational structures (i.e. its economic systems) must follow.

My research mobilizes faunal evidence from Hattuşa and Çadır from before and after the Hittite collapse in order to engage with and question this narrative. In approaching societal collapse through zooarchaeology, my work builds on approaches to collapse that emphasize the importance of studying the processes of social reorganization and regeneration that occur after collapse, focusing on the intertwined nature of what comes before and what comes after (e.g. Schwartz and Nichols 2006). This conception of collapse provides a critical framework for my

zooarchaeological approach, which has focused on how studying animal economies pre-collapse and post-collapse can offer insight into changing organizational structures and lifeways.

The results of my research show that, while changes in central Anatolian economic organization did occur following the collapse of the Hittite empire, the nature of these changes does not always follow the trajectories assumed in conventional narratives of collapse. For example, it appears that a major reorganization of the animal economy at Çadır occurred as the Hittite state lost its influence in central Anatolia, but its configuration is not one that was anticipated. In addition, the dissertation results suggest that the complexities of pre- and post-collapse animal management at Hattuşa are not well accounted for by our existing models of Hittite political and economic organization or of the empire's collapse. Taken as a whole, these results demonstrate a need to rethink how we envision the Hittite empire's political and economic organization, while presenting new ways for thinking about what happens after "The End."

# CHAPTER 1

## INTRODUCTION: COLLAPSE AND THE CONTEMPORARY

### 1.1 Statement of the Problem

From Edward Gibbon's classic *History of the Decline and Fall of the Roman Empire* to Jared Diamond's bestselling *Collapse*, questions surrounding societal failure have long captured our collective imagination. The ubiquity of this theme in popular culture—exemplified by the post-apocalyptic landscapes of *Mad Max*, *The Road*, and *The Hunger Games*—speaks to our enduring fascination with this topic. Why do societies fail? And when they do, what happens next? What does it mean to say a society has failed? Failed for whom? What are the specific political and economic effects of collapse? And how might we disentangle them?

The goal of this dissertation is to enhance our understanding of collapse and its aftermath using the disintegration of the Hittite empire in central Anatolia (present-day central Turkey) at the end of the Late Bronze Age (1600-1200 BC) as a case study. The Hittite collapse was part of a larger, regional collapse “event” that simultaneously affected multiple states across the Eastern Mediterranean during the twelfth century BC. This period, it is typically argued, was characterized by significant political and economic disruption throughout the eastern Mediterranean, and the subsequent period has often been understood as a “Dark Age” (Van de Mieroop 2007).

Regarding the Hittite case, it is widely agreed upon that the Hittites, an Indo-European speaking people with a particular dynastic history that centered on a royal court located at the capital city of Hattuša in central Turkey, came to dominate much of Anatolia and the surrounding region in the latter half of the second millennium BC. The standard narrative of their collapse tells us that the beginning of the twelfth century BC was characterized by increasing

turmoil in the Hittite lands and the surrounding region. The reigns of the last three Hittite kings were plagued by growing unrest brought on by a massive drought and subsequent famine, power struggles within the royal lineage including an assassination plot, and an increasing threat of invasion (e.g. Bryce 2005; Collins 2007; Cline 2014a). By around 1180 BC (according to the short chronology), the reign of the last Hittite king, Šuppiluliuma II had ended. The Hittite royal court had fled the capital at Hattusa, and the city's inhabitants had carefully packed up everything of value and took it with them when they left. By the time the Kaska, the longtime enemies of the Hittites, arrived to set fire to the city, the settlement was already mostly abandoned (Seeher 2002). The reign of the Hittites in central Anatolia had reached its end.

This isn't to say, however, that life in the former Hittite lands came to a grinding halt at the end of the Late Bronze Age. Even at Hattuša, which had been the Hittite capital, archaeological work shows that there was continuous occupation across the Late Bronze/Iron Age transition.

Focusing on the Hittite case, a major goal of this dissertation is to offer a critical assessment of multiple narratives that frequently have been used to characterize the Hittite collapse and its aftermath, and that also feature strongly in the broader literature on societal collapse, both ancient and modern (discussed in Chapters 2 and 3). At its most basic level, the strongest of these narratives, hinted at above, is that collapse signals "the end." But the end of what, exactly? One of the goals of this research is to explore what it meant to be a subject of the "Hittite empire," how this may have differed according to one's position within the empire's social, economic, and political structures, and how the impacts of the empire's collapse were differently distributed across its former territories. This research strives to help us understand

how societal collapse affects the day-to-day aspects of people's lives, and it asks how these changes, if there are changes at all, might be expressed materially.

This narrative of collapse as “the end” is often manifested through the assumption of a very high degree of political and economic integration such that when an empire's political systems collapse, its economic systems must also fail. In the case of central Anatolia and the Hittites, it has generally been assumed that the Hittite empire had a strong degree of political and economic centralization (for instance, collecting taxes taken in kind and redistributing animal wealth) and that after its political collapse, the empire's economic systems must have therefore collapsed as well.

Additionally, narratives of collapse in the ancient world more often assume a differential integration of urban centers and rural sites in a state's systems of organization, which entails that smaller, rural settlements are less affected by the state's collapse, since (it is thought) they were less firmly embedded in its political and economic systems in the first place. In the Hittite case, it is generally assumed that lifeways at the Hittite capital were the most strongly affected by the Hittite collapse, and that the further one moved away from Hattuša and into the provinces, the less impact the removal of the imperial superstructure had on daily life in less “important” places.

What the political disintegration of the empire actually meant for people living across the empire, in both the cities and the provinces remains unclear, and there has been little exploration of the degree to which the Hittite capital and its provinces may have been differentially affected by the regional destabilization at the end of the Late Bronze Age. Moreover, although alterations to central Anatolian lifeways (e.g. shifts in residential architecture, ceramics production techniques, etc.; see Chapter 2) clearly occurred during the transition from the Late Bronze to the

Early Iron Age (1100-900 BC), the significance of these changes in material culture and their relation to the large-scale political and economic changes occurring in the region during this “Dark Age” remain poorly understood and generally unarticulated.

The research presented here offers a critical assessment of these narratives through the examination of archaeological materials from both the Hittite capital of Hattuša and from Çadır Höyük, a provincial center. Through the analysis of faunal remains from both of these sites, I discuss evidence for changes and continuities in the use of animals and their products associated with the Hittite collapse and its aftermath. Studying the organization of animal economies at these sites both pre- and post-collapse allows for the characterization of production, provisioning, and consumption practices at these sites. This information, in turn, offers a window into what collapse *meant* in different parts of the empire and how local responses differed.

In order to understand collapse, we have to define the systems that were in place pre-collapse, and despite a vast corpus of texts (e.g. Beckman et al. 2006; Hoffner 1974), we still have a limited understanding of the relationships between capital and province in the Hittite world, as well as the economic organization of these sites and their subsistence systems. Consequently, in order to consider how people living throughout the Hittite empire, both in the capital and in the provinces, experienced its dissolution, we must also flesh out our understanding of the extent to which central Anatolia, once the Hittite heartland, was politically and economically integrated during the Late Bronze Age.

Bringing together anthropological and archaeological considerations of collapse and the zooarchaeological literature on complex societies, this research lays out for the first time a specific model for a zooarchaeological approach to collapse and its aftermath. This “zooarchaeology of collapse” focuses on studying changes and continuities in a society’s

“animal choices” (DeFrance 2009) pre- and post-collapse and views animals as a potential bridge for understanding linkages between everyday practices and organizational structures. It also recognizes human-animal relationships as multi-valent (not simply economic/functional). By employing evidence relating to the use of animals and their products in the Hittite empire and its aftermath as a case study, this approach provides a framework for engaging with and calling into question the collapse narratives outlined above.

This dissertation works to untangle these narrative threads by asking the following questions:

- 1) Did the broader regional destabilization in central Turkey following the collapse of the Hittite empire coincide with altered practices of production, provisioning, and processing of animal products?
- 2) Was the animal economy at Çadır less affected by the political changes in the region than that at the capital?
- 3) How was the mobilization of animals and their products organized at these two very different sites, and how well does this map onto conventional models for understanding urban and rural economies and what we expect to happen post-collapse?
- 4) How can the answers to these questions help us recalibrate our approaches to collapse?

Answering these questions about the ways in which people mobilized animal resources allows us to consider the extent to which the institutionalized political and economic order actually mattered in Hittite Anatolia, both in the provinces and in the capital. More broadly, it enables this research to ask, how might political collapse affect the economic decisions people make with regard to the use of animals and their products? How does the disintegration of a political superstructure affect life on the ground?

In order to lay the groundwork for these discussions, the remainder of this chapter aims to shed light on the broader intellectual history of societal collapse as concept and its entanglements with Enlightenment ideas of progress and western development. The discussion then turns to the relationship between the current socio-historic moment and how we approach the study of

collapse. Taken as a whole, this exploration provides important context for the dissertation research and how it was approached. Finally, the chapter-by-chapter organization of the dissertation is laid out at the end of the chapter.

## **1.2 Collapse, Ruin, and the Trope of Progress**

On January 23, 2020, the Bulletin of the Atomic Scientists announced that the Bulletin's Science and Security Board had moved its Doomsday Clock "closer to apocalypse than ever" (Bulletin of the Atomic Scientists 2020), citing the threats of nuclear war and climate change along with information warfare. At "100 seconds to midnight," the danger of societal collapse seems more imminent than ever, and conducting a quick Google search<sup>1</sup> for *societal collapse* provides first page results with titles like "Are We on the Road to Civilisation Collapse?" (Kemp 2019), "The Collapse of Civilization May Already Have Begun" (Ahmed 2019), and "End of Days: Is Western Civilisation on the Brink of Collapse?" (Spinney 2018).

Envisioning our world on the brink of collapse and in its aftermath— in other words, imagining our world in ruin — has long been part of the Western imagination (Lucas 2013: 192-193), as is the lasting association between collapse and ruination. Americans are obsessed with entertainment that showcases the destruction of famous national landmarks — for example, the New York skyline buried in snow in *The Day After Tomorrow* (Emmerich 2004) and the destruction of the White House in *Independence Day* (Emmerich 1996). However, long before the shocking reveal of the ruined Statue of Liberty at the end of *The Planet of the Apes* (Schaffner and Boulle 1968) (Figure 1.1), French artist Hubert Robert was portraying the Louvre and other French monuments as classical ruins (Figure 1.2). In the late eighteenth century,

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<sup>1</sup> Conducted on January 24, 2020.

Robert became known for his landscape portraits that frequently included picturesque depictions of ruins in Italy and France. In the period leading up to and following the French Revolution, he turned his work to contemporary monuments, which he depicted in the same style as his classical subjects. Hubert used this work to paint "...a bleak portrait of a future ravaged by time, open[ing] up numerous interpretations..." ("Hubert Robert: Painter of Ruins," n.d.). The implications of Robert's paintings may have been positive "...[suggesting] that the ruins of the newly redone Louvre [would] be as venerable as the monuments of ancient Rome" (Marcus 2016). However, they may also have represented a questioning of "...the merits and longevity of... [the] effort to ... [change] political systems after the French Revolution" ("Hubert Robert: Painter of Ruins," n.d.).



Figure 1.1 Still from the final scene of *Planet of the Apes* (Schaffner and Bouille 1968)

The ambiguity of Robert’s work points toward a fundamental tension in our understanding of ruins and of the past societies they symbolize. As Lucas (2013: 169) has pointed out, from the medieval period and continuing into the present, ruins have had an ambivalent place in the minds of western audiences, serving simultaneously as memento mori—reminders of the transience of all things—and as monuments—“reminders of a civilization or way of life [...that hint] at the possibility of immortality through material persistence....”



Figure 1.2 *The Monuments of Paris*, 1789, oil on canvas. Power Corporation of Canada Art Collection.

We can see Lucas’s “double meaning” at work as we consider how the fates of “failed” societies are often associated with their ruins, both in the popular imagination and in the archaeological literature. At the beginning of Tainter’s (1988:1) classic volume on collapse, the reader is presented with “lost civilizations” and “...cities buried by drifting sands or tangled jungle, ruin and desolation where once there were people and abundance.” These images of ruination have the power to simultaneously fascinate and unsettle: “Invariably, we are spellbound. We want to know more” (Tainter 1988:1). At the same time, however, “[these

images are] troublesome to all, not only for the vast human endeavors that have mysteriously failed, but also for the enduring implication of these failures” (Tainter 1988:1). Railey and Reycraft (2008) likewise call on such images in the introduction to their volume on collapse. After noting the romantic appeal of ruins, they ominously assert that “...[T]hese stunning monuments confront us with a dark message...: even the most advanced...and confident societies are vulnerable to total disintegration, and this message has unsettling implications for the future of today’s increasingly global society” (Railey and Reycraft 2008:1).

This “dark message” takes us in two directions. The first of these extends into the past, to the narrative of the history of the West, exemplified by the veneration of the Roman empire and its subsequent fall; the second extends into the future, to a world in atomic ruin (cf. Dawdy 2010:766). For generations, the fall of Rome has fascinated Western scholars and the public at large. Gibbon’s classic (1996 [1776]) *The Decline and Fall of the Roman Empire*, while considered outmoded by today’s standards, continues to influence how scholars conceptualize collapse (cf. Fotiadis 2006). Arguably, this enduring obsession with Rome as the “pinnacle of civilization” is at least partially responsible for the origin of our obsession with collapse. At the same time, the dark message communicated by the ruined monuments appeals to contemporary audiences obsessed with environmental collapse (cf. Diamond 2005; Lauterwasser 2017) and living in a world haunted by the threat of nuclear ruin (cf. Masco 2008).

The relationship between the environment and societal collapse has become a major topic of interest in recent decades as collapse studies has experienced an environmental turn. In Near Eastern archaeology, perhaps the most prominent example is Harvey Weiss’s work on climate change and collapse in ancient Mesopotamia and beyond (e.g. Weiss and Bradley 2001; most recently Weiss 2017; Kaniewski et al. 2015; Kaniewski et al. 2013). Attempts to place

contemporary concerns about climate change in relation to the ancient Near East (e.g. Cline 2014b; Weiss 2000) and to the archaeological record more generally (e.g. Altschul 2014) are not uncommon. Mayan archaeology, in particular, has been a hotbed of activity in this area (e.g. Peterson and Haug 2005; Yuhas 2015). However, Jared Diamond's (2005) popular bestseller *Collapse: How Societies Choose to Fail or Succeed* serves as the quintessential example of this general contemporary concern with the threats posed by environmental degradation and climate change in a globalized world. In framing his argument, Diamond, like the archaeologists above, draws heavily on images that that closely associate collapse and ruins.

At the beginning of *Collapse*, Diamond calls upon the simultaneously fascinating and unsettling qualities that ruins hold for contemporary audiences. He writes, "Lurking behind [the] romantic mystery is the nagging thought: might such a fate eventually befall our own wealthy society? Will tourists someday stare mystified at the rusting hulks of New York's skyscrapers, much as we stare today at the jungle-overgrown ruins of Maya cities?" (Diamond 2005: 3, 6). In a similar vein, Diamond chooses Percy Bysshe Shelley's romantic sonnet "Ozymandias" to serve as the book's epigraph. This poem describes the shattered remains of the colossal statue of king Ozymandias, often identified as Ramesses II of Egypt (Freedman 1986; Cline 2014a). In Shelley's sonnet, the power assumed in the fictionalized king's words ("My name is Ozymandias, king of kings: / Look on my works, ye Mighty, and despair!") is contrasted with the desolation of the surrounding landscape and the apparent destruction of Ozymandias' kingdom ("Nothing beside remains. Round the decay / Of that colossal wreck, boundless and bare / The lone and level sands stretch far away."). The abject failure of Ozymandias' kingdom as described in the poem speaks to the quiet fears about collapse that Diamond (rightly) expects his audience to experience.

The lasting association between collapse and images of ruination is striking, and it is also inseparable from western narratives of progress. As Lucas (2013: 192) points out, ruins “...are as much about the future as they are about the past, insofar as they act as media for the reflection of history and the trope of progress. Thus, in keeping Lucas’s characterization of ruins as both monuments and *momento mori*, we can situate Railey and Reycraft’s (2008) simultaneous fascination and dread within an intellectual history deeply preoccupied with ideas of progress (e.g. Hegel 1988 [1821]; Herder 2004 [1774]; Morgan 1877) and, at the same time, with the threat of its arrestment.

In making his critique of modernity, Benjamin (1968) builds precisely on this complicated relationship between ruins and progress. Instead of presenting a linear idea of the progression of history, he essentially turns the trope of progress on its head through his provocative depiction of the “angel of history” and the ruined wreckage of the past growing ever skyward at its feet (Benjamin 1968, Thesis IX; cf. Lucas 2013:192). Elsewhere, Benjamin argues: “Overcoming the concept of ‘progress’ and overcoming the concept of ‘period of decline’ are two sides of one and the same thing” (Benjamin 1999:460; cf. Dawdy 2009:142). To turn back to the idea of collapse, Benjamin’s assertion has important resonances with the progression of scholarly work in Near Eastern archeology.

In the intellectual trajectory of the archaeology of the ancient world, and of Near Eastern archaeology more specifically, we see an emphasis on progress and its arrestment (i.e. collapse) reflected in the idea of a linear progression of civilization from East to West. Marchand (1996:152) notes that “By 1810, Rome, Germandom, Greece, and the Orient had all become ideological markers as well as historical entities, available for politico-philosophical appropriation as well as for new applications of specialized expertise.” This kind of

appropriation is visible in references to “ruined” Near Eastern civilizations that served as a foundation of western state building (Wengrow 2010). Wengrow (2010) suggests that the ancient Near East held an ambiguous place in the political rhetoric of the nineteenth and early twentieth centuries. As a “birthplace” of “civilization,” the Near East played “an exalted role...in the making of the modern world” (Wengrow 2010:5), but there was an underlying idea “that civilization had since moved on, from ancient Near East to modern West” (Wengrow 2010:5).

The idea of linear progress embedded in these appropriations of the ancient Near East and its ruins is reflected in the reactions of European travelers “who wrote of [the region’s] neglect; of the loss of civilization and a subsequent reversion to some more primeval state” (Wengrow 2010:5). Thus, the collapsed societies of the ancient Near East were seen to have failed, and civilizational progress was built on their ruins. As Wengrow (2010:160-161) puts it, according to this view, “Ancient Near East meets modern West, and civilization passes between them in a direct exchange that excludes altogether the more recent history of the Middle East. Modern civilization, in this scheme of representation, is a unique possession of the West, but one nevertheless built upon (ancient) Eastern foundations.” At the same time, this conceptualization of progress introduces the idea of society as a totality, such that when collapse occurs, the society collapses in its entirety; the destruction is complete and final—thus the nineteenth century focus on ancient ruins which glosses over the reality of contemporary life in the Middle East. As will be explored in Chapter 3, this idea of society as a coherent and interlocking whole has tended to underlie many theorizations of collapse in the archaeological literature.

### 1.3 Collapse and the Contemporary

If, as Wengrow argues, civilization “left” the ancient Near East and was “passed on” to the modern West, it stands to reason that scholars, when faced with massive threats to Western civilization in the contemporary moment, would turn back to the ancient forebears of civilization for guidance. Among Near Easternists and scholars of the ancient world more broadly, the last decade has seen a surging interest in the study of past societal collapse, which dovetails with contemporary preoccupations surrounding geopolitical uncertainty (e.g. Galant 2020, “‘World War III’ Was Trending”); climate crisis (e.g. Carrington 2019, “Climate Crisis: 11,000 Scientists Warn of ‘Untold Suffering’”); mass extinction (e.g. U.N. Report 2019, “Nature’s Dangerous Decline ‘Unprecedented’; Species Extinction Rates ‘Accelerating’”); and global disease (Molteni 2020, “Could China’s New Coronavirus Become a Global Epidemic?”). Understandably, archaeologists have responded to these global threats by turning their attention to similar events in the past in order to provide insight into the present, the hope being that by studying collapse in the past, we might come to understand both how these societies “went wrong” and how to avoid their fates.

In the past five years or so, the number of anthropological, archaeological, and historical publications on societal collapse has skyrocketed. During this time, we’ve seen the publication of multiple edited volumes (e.g. Faulseit 2016; Cunningham and Driessen 2017; Weiss 2017), book-length general studies (e.g. Middleton 2017b; Johnson 2017), regional analyses (e.g. Murray 2017; Harper 2017), and the first review article on the archaeology of collapse in quite some time (Middleton 2017a; cf. Tainter 2006). Moreover, “classic” examples of collapse in the past have been made new again with fresh analyses. The year 2017, for example, included the publication of two works that offered differing approaches to the fall of the Roman empire:

Harper's (2017) *The Fate of Rome: Climate, Disease, and the End of an Empire* and Storey and Storey's (2017) comparative analysis, *Rome and the Classic Maya: Comparing the Slow Collapse of Civilizations*. Likewise, the Late Bronze Age collapse in the Eastern Mediterranean, last given a book-length treatment by Robbins (2001), got fresh press with Cline's (2014a) publication *1177 B.C. The Year Civilization Collapsed*. It is worth noting that Cline's text is aimed toward both expert and general audiences. Its publication caught the attention of national news outlets including *NPR* (Frank 2014) and the *New Yorker* (Gopnik 2014), and it was accompanied by a *New York Times* op-ed, which Cline (2014b) titled "Climate Change Doomed the Ancients."

Cline's (2014a; 2014b) discussion of the collapse of the Bronze Age "brotherhood of kings" (which included the Hittite empire, among other Eastern Mediterranean and Near Eastern states), is explicitly framed in terms of its relevance to contemporary comparanda, and to the history of the West. This is reflected both in the title of his *New York Times* op-ed (Cline 2014b), which echoes our rapidly growing concern with contemporary climate change (also exemplified by Weiss's [2017] recent edited volume on examples of megadrought in the past). It is also visible in the opening sentences of *1177 B.C.*, which read:

The economy of Greece is in shambles. Internal rebellions have engulfed Libya, Syria, and Egypt, with outsiders and foreign warriors fanning the flames. Turkey fears it will become involved, as does Israel. Jordan is crowded with refugees. Iran is bellicose and threatening, while Iraq is in turmoil. AD 2013? Yes. But it was also the situation in 1177 BC, more than three thousand years ago, when the Bronze Age Mediterranean civilizations collapsed one after the other, changing forever the course and future of the Western world. (Cline 2014a: xv)

Thus, it becomes clear that, now as ever, the stories we tell about life in the past are also stories about life in our present. These stories, though ostensibly about ancient history, can reveal much about our contemporary anxieties and our hopes for the future. At the same time, it is

important to consider how these entanglements between past and present impact how we come to interpret and understand the evidence we find in the historical and archaeological records. A recurrent theme in this research on the Hittite collapse and its aftermath is how our contemporary concerns and our understandings of our own society (the modern nation state) shape how we interpret the past. In other words, it may be argued that, intentionally or unintentionally, we tend to project these aspects back onto past societies, particularly as they relate to our conception of what societal collapse is and how it functions. Through an examination of the Late Bronze Age Hittite state and its collapse, this dissertation examines how many common collapse narratives (mentioned in the first section above) are closely tied to how we understand society in the present.

#### **1.4 Organization of the Dissertation**

Chapter Two (“Collapse in Context: Economy and Society in Central Anatolia in the Bronze and Iron Ages”) characterizes social and economic organization in central Anatolia before and after the Hittite collapse. In order to do so, it reviews previous work on the Late Bronze and Early Iron Ages, first presenting what have been taken to be the defining characteristics of these periods. It then discusses the political and economic relationships between capital and provinces in the Hittite empire, as well as our current knowledge of the use of domesticated animals in the Hittite world and their place within broader Hittite economic structures. Finally, the chapter introduces and provides background on the two research sites, the Hittite capital, Hattuša, and a rural center, Çadır Höyük. This discussion includes a brief introduction to the history of excavation at each site and a presentation of the excavation contexts where the materials studied for the dissertation were recovered (Kesikkaya South,

Kesikkaya Northwest, and Lower Town South at Hattuşa and the step trench and trench USS4 at Çadır), providing valuable context for interpreting the results described later in the dissertation. Taken as a whole, the chapter allows for an introduction of the collapse narratives mentioned at the start of the current chapter.

Chapter Three (“Toward a Zooarchaeology of Collapse” presents the theoretical framework for the dissertation and is divided into two halves. The first half of the chapter mobilizes anthropological and archaeological literature on societal collapse in order to push back against conceptualizations of collapse (which find their origins in social evolutionary frameworks and systems theory) that have tended to imagine the polity as a totality that will inevitably collapse in its entirety. The chapter presents a way forward that builds on framings of collapse that have emphasized the importance of continuity and studying the social processes that occur after collapse, arguing for the usefulness of approaching collapse as *process* rather than as final event. The second half of the chapter lays out a methodological framework for bridging between high level theoretical discussions of societal collapse and the Bronze and Iron Age archaeological evidence from central Anatolia. In particular, the focus is on imagining what a zooarchaeological approach to collapse studies might look like and what the study of animal remains can contribute to studies of societal collapse. In order to ground the discussion, zooarchaeological evidence is discussed from multiple collapse case studies (Teotihuacán in the Valley of Mexico, Cahokia in the American Bottom, the Khabur Basin in Syria at the end of the Early Bronze Age, and the Roman retreat from Britain). In doing so, an argument is made that zooarchaeological data can be used to test the validity of common collapse narratives.

Chapter Four (“Methodological and Interpretive Approaches to the Hittite Collapse

Using Animal Remains”) lays out the quantitative approaches that were applied in this study of societal collapse and provides a series of interpretive frameworks, in essence the middle range theory that is used to aid in the work at hand. Analytical categories for data analysis include recovery/taphonomy, species frequencies, survivorship/mortality, biometrics, and skeletal parts distributions.

Chapter 5 (“Results: The Management of Animal Resources at Hattuşa and Çadır Höyük in the Bronze and Iron Ages”) consists of a descriptive presentation of the results of data analysis. First, the results of a taphonomic analysis of the Hattuşa (Kesikkaya Northwest, Kesikkaya South, Lower Town South) and Çadır assemblages are presented. This is followed by a quantitative description of the Hittite (Middle and Late Bronze Age) and Iron Age assemblages at Hattuşa and Çadır for each of the analytical categories listed above. Each of these sub-sections ends with a comparison of the results from both sites.

Chapter 6 (“Summary: The Zooarchaeology of the Hittite Collapse and Its Aftermath”) considers significant trends in the results discussed in Chapter Five, and it places results directly in dialogue with the models set up in Chapter 4. In addition the data from Hattuşa (Kesikkaya Northwest, Kesikkaya South, and Lower Town South) are also put in conversation with the results of previous faunal reports from other areas of the site (Berthon 2017; Hollstein and Meddea 2014; von den Driesch and Pollath 2004; von den Driesch and Boessneck 1981).

The final chapter of the dissertation (“Synthesis and Conclusions”) synthesizes the results from Hattuşa and Çadır in order to offer a general sense of the changes and continuities in animal management at these sites before and after the Hittite collapse. These results are then considered in light of faunal analysis from other sites in the central Anatolian region and in relation to some contemporary directions in research on the organization of the Hittite empire. Finally the

discussion returns to the common collapse narratives introduced at the beginning of the dissertation, and the conversation attempts to address the broader implications of this new work for how we should think about collapse.

## CHAPTER 2

### COLLAPSE IN CONTEXT: ECONOMY AND SOCIETY IN CENTRAL ANATOLIA DURING THE BRONZE AND IRON AGES

“Thus pastoralism left its mark on Hittite society from top to bottom, represented by the king under whose crook all society lay down, as well as by the simple herdsman who tore his charges from the jaws of wolves and saw his children the subject of scorn.” (Beckman 1988: 44)

The above quotation, which dramatically closes Beckman’s (1988) classic article “Herding and Herdsmen in Hittite Culture,” encapsulates two ideas that are worth highlighting as we begin to consider socio-economic organization in central Anatolia during the late second millennium BC. First, Beckman’s words emphasize the animal economy as a key aspect of Hittite social life, an idea that is explored further in the chapter below. Second, the quotation underscores a top-down understanding of the Hittite world which is prevalent in the literature on the Hittites and which this chapter (and the dissertation as a whole) takes as one of its analytical objects.

In this chapter, I explore how evidence from ancient texts and the archaeological record have been used to characterize society in central Anatolia during the Hittite period (a period that largely overlaps with the Late Bronze Age, ca. 1600-1200 BC). I then place this framework in relation to evidence for shifts in political and economic organization after the Hittite collapse, moving into the Early Iron Age (1100-900 BC). This discussion highlights what have been understood as the defining characteristics of social and economic organization during these periods. In this chapter, I also discuss what we know about the political and economic relationships between capital and provinces in the empire, and I present our current knowledge of the use of domesticated animals in the Hittite world and their place within the broader economic structure. Looking toward the zooarchaeological analysis discussed in subsequent

chapters, this chapter ends with a discussion of the two archaeological sites (Hattuša and Çadır Höyük) and the specific excavation contexts that form the basis of research.

In laying out our current understanding of the Hittite empire, its collapse, and what came after, the overarching goal of the chapter is to create space for the exploration of a narrative which is often (but not always) left implicit in discussions of social change on the Anatolian plateau following the Bronze Age collapse. As mentioned in Chapter 1, this narrative, which has long been used to characterize the transition from the Late Bronze Age to the Early Iron Age in central Anatolia, assumes a shift from centralized to decentralized political and economic organization following the Hittite collapse. Further interrogation of this model using the faunal evidence from Hattuša and Çadır is, in turn, one of the goals of subsequent chapters.

## **2.1 Setting the Scene: The Hittites**

The Hittites, as we think of them today, were a royal court with a particular dynastic history, who used Hittite as their language of state, and were based in central Anatolia. Also known as the Anatolian plateau, this highland region is located in the heart of Anatolia, a large east-west peninsula in southwest Asia that comprises most of modern-day Turkey (Fig. 2.1). Two major rivers run through the region, the Kızılırmak in the east and the Sakarya in the west. The plateau is defined by several mountain ranges at its margins: the Pontic Mountains to the north, the Taurus Mountains to the south, and the Anti-Taurus Mountains to the southeast (Düring 2011; Sagona and Zimansky 2009). In spite of these seemingly-concrete topographic boundaries, the edges of the region can be quite porous when considered archaeologically, with some sites from outside this topographically-circumscribed area often included in considerations of the plateau due to cultural similarities (Steadman 2011). This is certainly the case for the

Hittites, given the wide geographic extent the empire would eventually reach – at its maximum extent, the edges of the empire reached from the Aegean coast of Anatolia in the west, across Anatolia and into northern Mesopotamia in the east (crossing the Euphrates and reaching as far as the Taurus River) and south to Damascus in the northern Levant (Bryce 2002; Hawkins 1986).



Figure 2.1 Major Bronze/Iron Age sites in central Anatolia (Ross et al. 2019a: Fig.1)

Much ink has been spilled on the Indo-European origins of the Hittites and the timing of their arrival in central Anatolia, but we know that Hittite speakers were present in central Anatolia during the Old Assyrian Trading Colony or Karum period (Middle Bronze I, 1900-1650 BC) (Hawkins 1986: 363-364). During this time, Assyrian influence extended into Anatolia in

the form of a vast trade network that included the establishment of trading colonies (karums) in Anatolia and northern Mesopotamia. Discussions of the Hittite kingdom often begin with Anitta, a Hittite king who ruled in the 17<sup>th</sup> century BC and authored the earliest known Hittite text. However, the Hittites truly began to come to power in central Anatolia when Hattušili, who reigned some decades later, founded the kingdom's capital on the site of an Assyrian trading colony called Hattuša, from which he took his throne name, around 1650 BC (Hawkins 1986: 363).

Though chronological approaches to Hittite history vary (e.g. Seeher 2011; Mielke et al. 2006), Hittite dominance in the region can be divided broadly into two phases<sup>1</sup>: the Old Kingdom phase (1650-1500 BC) and the Empire phase (1400-1200 BC). During the Old Kingdom phase, which began with the reign of Hattušili I, the people we now identify as the Hittites consolidated their control of central Anatolia (the Land of Hatti) and made the city of Hattuša (described in depth below) their capital. This phase was followed by a period of political uncertainty known mainly from texts; archaeological evidence that can be linked to this “intermediate period” is scarce. During the Empire phase, beginning with the reign of Tudhaliya I, the extent of Hittite control reached its height, and the Hittites became a major regional power, contending with major polities such as Babylonia (in southern Mesopotamia) and Egypt (whom they fought on equal terms at the Battle of Kadesh in 1274 BC) (Sagona and Zimansky 2009; Bryce 2005).

The Hittites referred to themselves simply as “the people of the land of Hatti” (Bryce 2005:19). The “land of Hatti” is a geographic designation that is largely consistent with how we

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<sup>1</sup> See Seeher (2011) for further discussion including a description of a three-phase approach that adds a “Middle Kingdom” phase.

define central Anatolia today, and which seems to have been in use for many centuries before the Hittites became the major political power in Anatolia. In fact, Bryce (2005:19) suggests that the Hittites' collective identity was based on this geographic location: "What gave them recognizable common identity, in their own eyes and in the eyes of their neighbors, was...the fact that they lived within a clearly defined region which differentiated them from other subjects of the king who lived further afield...." The Land of Hatti was thus set in contrast with the surrounding vassal states and competing foreign powers.

The geographic and ethno-linguistic origins of the Hittites are still very much a matter of debate (e.g. Bryce 2005; Renfrew 1987; Oettinger 2002), but a defining characteristic of the inhabitants of the Hittite state seems to have been diversity. Many languages were spoken in the Hittite heartland, and the people of the land of Hatti came from a number of language families: Indo-European (Luwian and Palaic), Hattic, and Hurrian, as well as individuals who came from Syria and Mesopotamia (Bryce 2005). In addition, the Hittites incorporated many religious beliefs (the 'thousand gods of Hatti') into their state religion (Hutter 1997:78).

Spatially, the geographic distribution of the Hittite state, particularly during the Empire phase, can be thought of in terms of several regions which had somewhat porous boundaries (Glatz 2009). At the heart of the empire were the central regions (the Land of Hatti), consisting of the capital and its provinces. Beyond this lay numerous vassal states, which were considered part of the empire and were required to send tribute to the Hittite king but which maintained a certain degree of autonomy and which were incorporated into the empire with many of their own political and social systems intact. At the very edges of the empire was the frontier region. The Hittite polity claimed the frontier as part of its territory, but with rare exceptions, little of the capital's influence was felt in these far-flung reaches of the empire. Though elements of Hittite

material culture reached into the frontier (Hittite iconography for example), the empire's control for the most part did not (Glatz 2009).

## **2.2 Characterizing the Hittite Polity**

It has generally been assumed that political and economic life within the Land of Hatti was fairly centralized. This is based on interpretations of written evidence found in Hittite texts as well as on interpretations of typical characteristics of Hittite material culture. Aspects of Hittite material culture that have been used to point toward centralization include architecture, ceramics, and administrative artifacts. The architecture at excavated sites is fairly uniform, as are the artifacts recovered there (Seeher 2011:389). These signs of “uniformity” across multiple lines of material evidence have often been used by Anatolian archaeologists as a shorthand for political and economic centralization.

Some characteristic artifacts of the period include stamp seals made of metal, stone, and ivory; and clay bullae, all of which are administrative in nature and were used by Hittite kings and officials to seal “letters, contracts, consignment of goods, and even...the locking bolts of city gates” (Seeher 2011:387). Hittite pottery tends to consist of a highly standardized, mass-produced monochrome “drab ware” made from a relatively coarse fabric. These ceramics are rarely decorated and changed little over the course of the Late Bronze Age (Sagona and Zimansky 2009: 273; Seeher 2011: 384). The level of standardization displayed by this pottery has been seen as evidence for centralized pottery production administered by the Hittite Empire (Seeher 2011: 386; Gates 2001: 141), but alternative explanations have also been suggested (c.f. Glatz 2009; Korbøl 1985; Postgate 2007). Also worth noting is that, for decades, Hittite ceramics were classified based primarily on pottery that had been excavated at the Hittite capital of

Hattuša (e.g. Fischer 1963), but recent work by Schoop (2006) re-evaluating the classification system there as well as work at other sites has led to a more diverse understanding of the ceramic sequence (Seeher 2011: 384).

Much of the detailed textual information we have about the Hittites focuses on elite society, particularly on aspects of royal life and royal administration, and the power of the king is generally portrayed as being extensive and absolute (Bryce 1998, 2002; Schachner 2011). It has been argued that “[l]ife in Anatolia under Hittite rule was highly regulated” (Collins 2007: 111), and this extremely hierarchical social organization had numerous trickle-down effects, from laws and taxes that were imposed on the populace, to the general social order. Aside from what the ancient inscriptions tell us about the king, his court, and his royal officials, the texts also mention a variety of professions (scribes, farmers, merchants, warriors, craftsmen) (Bryce 2002). These individuals receive relatively little documentary attention, but their importance to the Hittite empire cannot be discounted, at least from the perspective of the state:

In this world, every farmer, craftsman, and soldier labored to benefit the state. Every festival that was performed, piece of sculpture that was fashioned, or tablet that was inscribed ultimately served the interests of the king. The palace economy of the Late Bronze Age effectively centralized control of Anatolia’s resources even as it inexorably bound the inhabitants of the land who were dependent on those resources to the ruling house. (Collins 2007: 111-112)

This idea of centralized control over resources is explored further below, but it is worth emphasizing here the importance of these “invisible” sectors of society (Stein 2005). Though king and court are central figures in the texts, “[s]mall-scale farming and animal husbandry formed the backbone of the Hittite economy” (Collins 2007: 112), and a tithe on the resources produced by these farmers and herders was the main source of royal revenue (though tribute from vassal states and military booty were also key parts of the state income) (Collins 2007).

### **2.3 Relations between Capital and Provinces in the Hittite Empire**

Given the limited visibility of individuals such as farmers and herders in the texts, it is unsurprising that the rural areas in which they tended to live have also received limited attention by archaeologists and Hittitologists. In one of the few articles dedicated to discussing the interactions between city and countryside in the Hittite world, Beckman (1999) specifically refers to the relationship between the Hattuša and its provinces as being neglected in the scholarly literature. However, based on what we know from the Hittite texts, there is general evidence for centralization in governance between capital and provinces. Drawing on these sources, Beckman's depiction of the role played by the capital is quite exploitative, which dovetails with Collins' description above. He describes Hattuša as "a center of political power which coerce[d] its sustenance from the surrounding agriculturalists and pastoralists" (Beckman 1999: 165). He also notes that the capital was supported primarily through "booty, tribute, or diplomatic exchange" (Beckman 1999: 167)

Collins (2007) describes some aspects of how this kind of exploitative interaction played out in the provinces. Also drawing from textual evidence, she notes that towns across the empire had councils of elders "whose members functioned as local politicians" (Collins 2007: 105) and that the further the town was from the capital, the greater the political role these councils played. At provincial towns in the heartland (such as Çadır), the councils had a relatively limited function. Collins (2007: 105) writes: "[T]heir role was limited to assisting state-appointed officials with judicial and cultic matters" (Collins 2007: 105). She further indicates that such towns had only a very limited degree of autonomy: "Aside from the elders, locals did not participate in their own governance; rather, administrators were selected from among the few families that made up the ruling elite" (Collins 2007: 105). The situation was in some ways

similar in the districts along the Hittite frontier, where district governors were closely monitored by the state and were “given little leeway for individual initiative..., [returning to Hattuša] frequently to report in person” (Collins 2007: 105).

More recently, Glatz (2009) has begun to call this understanding of the Hittite empire as extremely centralized and regulatory into question. In her article “Empire as Network: Spheres of Material Interaction in Late Bronze Age Anatolia,” Glatz works at a very large regional scale, focusing on the relationship between the central regions of the empire, its frontier, and everything in between. Her work points toward the complexity of regional political relationships and Hittite “control” in different areas of the empire. Her research examining multiple lines of material evidence (ceramics, settlement patterns, the presence or absence of north central Anatolian glyptic writing, and landscape monuments), identifies multiple spheres of influence at varying distances from the empire’s center and suggests that control in the heartland (where the town of Çadır Höyük was located) was greater than on the frontier, at the empire’s edges (Glatz 2009: 137). Simultaneously, she pushes back against top-down characterizations of power in the Hittite world. Moreover, the fact that she does not include small site data in her survey of the heartland (her only data come from major urban centers) leaves room for further exploration of this topic, particularly of the degree to which imperial control may have differed at rural sites versus urban ones, which is addressed through the analyses in subsequent chapters.

## **2.4 Hittite Animal Economies**

As mentioned in the opening of this chapter, in his article on herding in the Hittite world Beckman (1988) emphasizes herding as a central aspect of Hittite economic organization. In this piece, which is the only article specifically on the subject of Hittite pastoralism from a textual

perspective (though for Hittite ritual use of animals, see Collins 1995; 2006), he asserts, “The importance of herding as a major constituent of the Hittite economy is easily demonstrated....”

(Beckman 1988: 33). Beckman goes on to elaborate:

The Hittite Laws devote several paragraphs to the theft of herd animals, and the tariff gives prices for these creatures as well as their meat. Paragraph 53 [of the law code] attributes cattle and sheep, as well as dependent personnel, to a typical farmstead, while a royal donation of land indicates that agricultural properties were provided with varying numbers of cattle, sheep, horses, and asses. (Beckman 1988: 33-34)

This is paralleled by the description of “well-developed animal husbandry” (Dörfler et al. 2011: 99) in a recent review article on the environment and economy of the Hittites, which takes a more zooarchaeological approach to the subject.

However, the summary of herding Beckman presents derives heavily from administrative texts that describe how the royal flocks were administered and from ritual texts, which were also written and used by elite segments of society. While the laws Beckman cites above may well have been felt throughout the empire (or at least its heartland, considering Glatz’s [2009] work), for the most part the textual evidence that mentions animals presents an elite perspective and does not necessarily represent animal management as it was practiced throughout the empire. Beckman notes that “herding was a calling of low status in Hatti” (1988:38), but the flocks being herded in the texts that Beckman describes belonged primarily to the royal bureaucracy, and his research highlights the many laws and restrictions that functioned to ensure that these royal herds were protected (e.g. texts about what would happen in the event of theft, who was responsible for the flocks in various scenarios, etc.). These kinds of examples help contribute to an image of animal management as being closely administered by the Hittite state, but this may well result from the particular perspective of our sources. Certainly it paints a picture of pastoralism that is marked by centralized control, but for an understanding of animal husbandry outside of elite

contexts (as well as to supplement what the texts tell us about the management of the royal flocks), it is necessary to examine the animals' material remains.

In terms of the zooarchaeological evidence, most studies of animal remains from Hittite period and Iron Age sites in central Anatolia to date have been generally descriptive (e.g. von den Driesch and Boessneck 1981). In “Environment and Economy in Hittite Anatolia” (which provides the only summary of Hittite animal economies to date), the authors note, “As animal bones from archaeological excavations are primarily kitchen refuse, they inform us primarily about which animals people kept and what meat they ate” (Dörfler et al. 2011: 115). This focus on subsistence, rather than broader economic/social concerns is not uncommon. However, an argument for the broader value of such analysis, particularly regarding the value of animal remains for informing studies of societal collapse, will be made in subsequent chapters.

Moreover, in most zooarchaeological reports pertaining to the Hittites, the discussion as it interfaces with economic concerns (e.g. defining the focus of caprine production strategies) has been largely descriptive. For instance, once the production strategy – whether for meat or wool or dairy – has been identified, there is little additional consideration (e.g. what are the broader implications if herders chose to focus on intensive wool production rather than subsistence production?). In addition, to date, there has been very little synthetic work combining comparative data from the various zooarchaeological reports on the Hittite and Iron Age assemblages. Hongo (1996) does provide a summary of zooarchaeological work that had been carried out at various sites at the time that she completed her dissertation, but she does not include any comparative analysis, and quite a few new reports have emerged in the past two decades.

Furthermore, no work has been done to compare the animal economies at major centers and smaller provincial sites in central Anatolia for the Hittite period and the Iron Age. The short review found in Dörfler et al. (2011) emphasizes that three major domesticates (cattle, sheep, and goat) were the focus of Hittite animal husbandry and suggests that “the Hittites had a good knowledge of how to maintain and breed them” (Dörfler et al. 2011: 115), assertions that are well-corroborated by faunal evidence from other Hittite sites. At the same time, however, these and other generalizations in this summary piece are based on animal remains from only two major sites (the capital Hattuša and Kuşaklı-Šarišša) and do not take small settlements (e.g. Çadır Höyük and the nearby settlement of Kaman-Kalehöyük) or urban centers that are slightly further away (e.g. Gordion) into account.

## **2.5 The Hittite Collapse**

The collapse of the Hittite Empire around 1200 BC marks the beginning of the Late Bronze-Iron Age transition in central Anatolia. Explanations for the Hittite collapse vary considerably and remain an object of scholarly debate (Cline 2014; Kealhofer and Grave 2011:423). The end of the Hittite empire also coincides with a broader regional destabilization which affected polities across the Aegean and Eastern Mediterranean at the end of the 13<sup>th</sup> century. The “great powers” affected included the Hittite empire, Egypt, Mycenae, and Babylonia, with smaller Levantine polities, such as Ugarit, also being affected. For decades, this regional collapse was attributed to a group of invaders referred to in Egyptian inscriptions as the “Sea Peoples” (Sandars 1985; Drews 1993). The exact origins of the Sea Peoples are still unknown, but according to the inscription of Ramesses III at Medinet Habu, they were to blame for the Hittite collapse (Adams and Cohen 2013; Cline 2014). He wrote, “All at once the lands

were removed and scattered in the fray. No land could stand before their arms, from Hatti, Qode (Cilicia), Karkamis, Arzawa, and Alasiya (Cyprus) on, being cut off at one time” (Edgerton and Wilson 1936: pl. 36 qtd. in Collins 2007: 78). Recent work, however, has noted that ceramic types associated with the Sea Peoples are absent from the Hittite heartland (Genz 2013). Other arguments concerning causes of the Hittite collapse in particular have included environmental changes which triggered widespread famine, political instability, and influxes of immigrants from the east or west (Bryce 2002, 2005; Cline 2014; Kaniewski et al. 2013; Kealhofer and Grave 2011; Singer 2000; Sherratt 1998; Yakar 2006).

It seems likely that a combination of some (if not all) of these potential causes led to the empire’s collapse. Of the explanations mentioned above, Collins points toward “internal dissension” (2007: 76) and the fact that, as the power of the kings waned and the empire became more politically unstable, “the population, especially in the west, was becoming increasingly restive as years of famine brought on by unfavorable climatic conditions in the dry farming regions of Anatolia took their toll” (2007: 76).

Schachner (2020: 393-394) also points to internal tensions within the empire as a major factor in the disintegration of the Hittite state. He notes that shifts in Hittite ideology and religion had occurred as a result of the empire’s gradual expansion to the south and that there was a need to incorporate these new southern populations into the empire. The Hittite’s top-down ideological approach, which included “a common centralized religion and the use of Hittite as a common language of the empire’s elite” (Schachner 2020: 393) had already been used “during the early empire to culturally integrate very heterogeneous social groups into one state” (Schachner 2020: 393), and changes to the state religion and ideology later in the empire period may have resulted in “...the deterioration of the social...[and]...ideological homogeneity and

cohesion of the Hittite society” (Schachner 2020: 394). The loss of this social cohesion might have had a major effect on the Hittite state, Schachner suggests, arguing that “[d]ue to the general geographical obstacles of the region, the Hittite economic, political and social system was always fragile and only a slight weakening of the social coherence would strengthen the traditional Anatolian diversity, which was only partially overcome by the Hittite Empire” (Schachner 2020: 394).

During the reigns of the last three Hittite kings (Tudhaliya IV [1227-1209], Arnuwanda III [1209-1207], and Suppiluliuma III [1207 - ?]), the Hittite empire gradually declined in terms of its political coherence (Bryce 1998). However, even before this, no later than the first half of the 13<sup>th</sup> century BC, “...there were large wastelands in various...areas of the city” even as monumental building projects continued elsewhere (Schachner 2020: 391). Particularly during the reign of Suppiluliuma III, the textual record grows extremely sparse.

Around the time of the empire’s collapse (conventionally dated to approximately 1200 BC), a number of official buildings around the Hittite capital of Hattuša show evidence of damage by fire. However, when the destroyed areas were excavated, only “unimportant” and immovable objects had been left behind, suggesting that the city was likely abandoned before it was burned (Seeher 2001; Schachner 2020). It is possible that the Hittite royal court abandoned Hattuša and moved elsewhere (probably to the south, where the Neo-Hittite kingdoms would later emerge, see below), but to date no archaeological or textual evidence for this exists (Schachner 2020: 394).

## 2.6 Transition to the Iron Age and Subsequent Developments

With the collapse of the Hittite empire, central Anatolia entered what has been characterized historically as a “Dark Age.” This shift represents the transition from what has typically been characterized as the political centralization of the Late Bronze Age to the fragmentary and decentralized political and economic landscape of the Early Iron Age (1100-900 BC) (Hawkins 2002; Fischer et al. 2003; Kealhofer and Grave 2011:435; Schachner 2011; Seeher 2001). During this period, the textual record is largely silent, and our only evidence as to how life changed (or remained the same) after the Hittite collapse comes from the archaeological record.

Numerous material transformations have been associated with the social developments taking place in central Anatolia during this time, and many of these have been associated with a shift to decentralized political and economic organization. In contrast with the above-ground construction practices that characterized the Late Bronze Age, evidence for semi-subterranean structures appears at central Anatolian sites during the Early Iron Age (1100-900 BC) (Ross 2010), and the monumental architecture that was a major feature of the Hittite period disappears. There is also a shift in methods of pottery production, with the standardized, mass-produced wares of the Late Bronze Age being replaced by handmade pottery (Schoop 2006; Glatz 2009). This manufacturing shift has generally been taken to be suggestive of a shift to more localized economic production. (Interestingly, in the case of Çadır, some of the handmade transitional pottery imitates wheel-made styles [Ross 2010].) Moreover, scholars have emphasized the apparent mobility of populations following the Hittite collapse, given that abandonment occurred at many sites throughout the region during the Late Bronze/Early Iron Age transition (Kealhofer and Grave 2011: 423). As a result, the degree of cultural continuity in central Anatolia following

the Late Bronze collapse has been questioned. However, as Bryce (1998: 381) notes: “While centres like Hattusa...succumbed to total destruction, the evidence for devastation in the regions [it] once dominated is far less marked.” Current archaeological evidence indicates that some sites were occupied continuously across the Late Bronze-Iron Age transition (e.g. Kaman Kale-höyük; Çadır Höyük; Gordion). Even at the former Hittite capital Hattuşa, where there was some evidence of destruction by fire, Early Iron Age remains are present, though the occupied size of the settlement was greatly reduced. Parts of an Early Iron Age settlement, featuring many of the material characteristics that have come to characterize Early Iron Age material culture in central Anatolia (e.g. a shift from wheelmade to handmade pottery; a shift to semi-subterranean houses) have been excavated at Büyükkaya, a rocky outcropping at the northeast end of the site (Seeher 2002:170-171; Kealhofer and Grave 2011:423).

In their summary of the Iron Age in central Turkey, Kealhofer and Grave (2011:435) note that the Early Iron Age in the region “... is seen as a period of cultural and political fragmentation,” citing Genz (2003) and Summers (2008). The Middle Iron Age, on the other hand, they write is “...a period of political consolidation, albeit with considerable regional variation” (Kealhofer and Grave 2011:435). Though the Early Iron Age occupation at the former Hittite capital was limited, during the Middle Iron Age, the settlement grew considerably, “...with evidence for both public buildings and fortified occupation areas,” becoming once again “a larger regional political center” (Kealhofer and Grave 2011:424). Elsewhere on the central Anatolian plateau, the site of Gordion (Yassı Höyük) on the Sakarya River, also grew substantially moving into the Middle Iron Age. While Early Iron Age contexts at the site were largely domestic, the Middle Iron Age saw the sudden emergence of a substantial, fortified settlement at the site, coinciding with the development of the Phrygian state in the region

(Kealhofer and Grave 2011:428-429), which over the next several centuries would become a local regional power. Meanwhile, approximately 10 km away from Çadır Höyük, the large fortified site of Kerkenes Dağ (Summers 2006), dating to the Middle through Late Iron Ages, would have also been a substantial presence on the Anatolian plateau and “must have had a strong, albeit shortlived, influence on the neighboring population at Çadır (Kealhofer and Grave 2011: 428).

Moving outside the bounds of central Anatolia, it’s also worth noting that the Iron Age in southeastern Anatolia and northern Syria was dominated by the so-called Neo-Hittite or Syro-Hittite states (Bryce 2012). These kingdoms, which include Carchemish and Malatya among many others, emerged in the mid-12<sup>th</sup> century BC and lasted until the 8<sup>th</sup> century BC when they were incorporated into Assyria (Bryce 2012:47). The Syro-Hittite kingdoms share a number of key aspects which link them symbolically to the Hittite empire. These include the use of Luwian script for inscriptions; Luwian was the language/script used by Hittite kings late in the empire period for royal inscriptions, providing “...an apparent link with the later Iron Age kingdoms” (Bryce 2012:47). Additionally, Syro-Hittite kings sometimes used the names, “...in Luwianized or Assyrianized form, of Late Bronze Age Hittite kings” (Bryce 2012: 47), and, materially, the Syro-Hittites mobilized Late Bronze Hittite iconography and architectural styles (Bryce 2012:47). The exact relationship between the Syro-Hittite kingdoms and the Bronze Age Hittite state is still a matter of debate when it comes to the possible relationships between these Iron Age kings and the Late Bronze Age Hittite royal court (Bryce 2012; Hawkins 1995). However, even if their claims of descent are purely symbolic, the emergence of the Syro-Hittite kingdoms and their use of Hittite state apparatus points toward an interesting kind of continuity, in which a form of the Hittite state continued on long after the Hittite homeland had been abandoned.

## 2.7 Sources and Limitations

In thinking through what we know about the Hittite empire, its collapse, and what came after, it is important to consider in slightly greater depth how the data are derived. Our knowledge of the Bronze and Iron Ages in central Anatolia, detailed above, is based on three forms of evidence: written evidence drawn from the Hittite textual record, material evidence from excavated sites, and (most implicitly) comparative analogy. All of these are subject to certain limitations, a handful of which are outlined here in an effort to more explicitly define the nature of and constraints on our knowledge of the Late Bronze and Early Iron Ages in central Anatolia. Simultaneously, this discussion serves to illuminate some of the gaps that still exist in our understanding of this time and place that has been the locus of scholarly attention for well over a century.

Much of our understanding of the Hittites derives from the study of texts the Hittites left behind. However, compared to other bodies of ancient texts (e.g. those from Mesopotamia), the Hittite corpus is relatively small and is subject to various limitations, both in terms of temporal range and topical scope. For example, the vast majority of Hittite administrative texts (which are used for reconstructing Hittite economic organization) date to the reigns of just two kings (Hattusili III and Tudhaliya IV [ca. 1269-1209 BC]), and most of these focus on expenditures in the religious sphere (Burgin 2016:2). Additionally, Hittite texts are recovered mainly from elite sites/major centers (e.g. Hattuša and Kuşaklı-Šarišša). Texts from provincial sites, on the other hand, are much rarer. At Çadır Höyük, for example, no examples of Hittite texts have ever been recovered in spite of over two decades of excavation.

At the same time, the material record poses its own limitations. According to the textual evidence, we know that there should be a large number of Hittite sites scattered throughout

central Anatolia. However, to date, the number of Late Bronze Age exposures has been relatively limited (Sagona and Zimansky 2009:273). Excavations at both large centers (e.g. Hattuša, Kuşaklı-Šarišša, Ortaköy-Šapinuwa, and Alaca Höyük [Schachner 2011; Müller-Karpe 2002; Süel 2008]) and smaller rural sites (e.g. Çadır Höyük and Kaman Kale-höyük [Steadman et al. 2015, 2013; Omura 2011]) have significantly expanded our knowledge in recent decades. However, much of what we know still derives from the capital city, Hattuša (see below). This major urban center has a history of excavation stretching back over a hundred years and has produced treasure trove of information about the Hittites and their world. However, it would be difficult to over-emphasize the exceptional nature of the site, both in terms of its scale and in terms of the kinds of artifacts found there. Thus, It is critical to keep in mind that the evidence uncovered at Hattuša cannot be taken as representative of Hittite social and economic organization as a whole, at least not without great caution.

A final area of difficulty is that of comparative analogy. Because of the limitations in our knowledge described earlier in this section, comparison is sometimes used to flesh out our models of life in the Hittite world, and the most convenient neighbor with which to do this is Mesopotamia. To provide an example, much of what we know about Hittite animal use is filtered through the textual evidence. However, unlike the relative wealth of textual evidence we have from Mesopotamia concerning the economic use of animals and their products (e.g. Steinkeller 1987; Zeder 1994), the picture for Anatolia is much less clear, both because of the limited number of available texts and because of their relatively narrow scope. At the same time, our understanding of Mesopotamian animal economies, which in some periods are described by a great number of texts that suggest very high levels of economic and bureaucratic centralization, has tacitly shaped how we imagine animal economies in Near Eastern polities more generally.

For example, in the very well-known third millennium Mesopotamian case of Drehem, the “texts reveal the presence of a highly centralized bureaucratic system...involved in, among other things, the movement of huge numbers of livestock through a specialized processing center...from which animals were then redistributed by the Ur III state” (Arbuckle 2012: 463). This particular example has been carefully applied to supplement the material evidence available at the Bronze Age Anatolian site of Achemhöyük, to great effect (Arbuckle 2012). However, it is important to maintain an awareness of the ways in which our general models for animal-based economic organization in Anatolia have been shaped by evidence from elsewhere in the ancient Near East, that cannot necessarily be applied in a “one animal economy fits all” manner.

## **2.8 Sites and Excavation Contexts**

To lay the groundwork for discussion of the faunal materials included in this dissertation, this final section of the chapter introduces each of the research sites, Hattuşa and Çadır Höyük along with the excavation contexts from which faunal materials were derived.

### *2.8.1 Hattuşa*

#### Background to the Excavations

Central to both the Hittite political sphere and our own understanding of the Hittites is the empire’s capital. The site of Boğazköy-Hattuşa is situated beside the modern-day village of Boğazkale (historically known as Boğazköy) in Çorum province in north central Anatolia. Boğazköy-Hattuşa was “discovered” in 1834 by Charles Texier, a French adventurer-explorer searching for an ancient Celtic city attested in Roman sources (Bryce 2002:1). Though the site had not yet been recognized as the Hittite capital, over the next sixty years, European travelers

visited Boğazköy and wrote about the Great Temple (Temple 1) and Yazılıkaya, which was known for its monumental rock reliefs and was later understood as the ritual sanctuary of the Hittite kings (Alaura 2006; Schachner 2011; Lehner 2015). The first substantial excavations at the site were carried out by Ernst Chantre in 1893 and 1894 (Chantre 1898). These excavations focused on Temple 1, Büyükkale (the elite citadel) and Yazılıkaya. The first systematic excavations began in 1906 under the direction of Theodore Makridi of the Istanbul Museum and Hugo Winckler of the German Oriental Society (Seeher 1995). It was at this time that Winckler identified the site as the Hittite capital on the basis of evidence unearthed in these excavations (Bryce 2002:2). Moreover, texts recovered by Chantre, Makridi, and Winckler contributed to the decipherment of Hittite and the publication of a Hittite grammar by Bedrich Hrozný a decade later (Hrozný 1917). Shortly after this in 1907, the German Archaeological Institute (DAI) oversaw its first excavations at the site. Since then, the DAI has overseen continuous excavations at Hattuşa, with major breaks taking place only during the World Wars and the Great Depression (Seeher 1995). Current DAI excavations are being carried out under the direction of Andreas Schachner.

The Hittite capital city spreads across 167 hectares and is surrounded by a 6 km fortification wall (Sagona and Zimansky 2009). While the occupation at the site dates to multiple periods spanning thousands of years, the vast majority of the remains at the site date to the Hittite Empire period and are the result of building projects undertaken by Hittite kings (Bryce 2002). The Hittite capital city consists of two main parts (Fig. 2.2). To the north is the Lower Town, a residential area which was the “original” part of the settlement and contains the royal acropolis (Büyükkale) in its southeast quadrant (Bryce 2002; Seeher 2002). It has been suggested

that most of the people who lived in the largely residential Lower Town were likely elite individuals who served the palace in some capacity (Seeher 2002). However, given the relatively low proportion of areas that have been excavated relative to the site's large size, this understanding should be approached cautiously. As Schachner (2020:381) has written recently about research at Hattuša, "...in the case of long-term excavations, researchers are forced to regularly rework older results in the light of new research, including results that may have long been regarded as doctrines." In the southern area of the settlement is the Upper City, which was occupied and contained monumental architecture beginning in the middle of the 16<sup>th</sup> century BC (Schachner 2020: 385-386). It overlooks the Lower Town, and contains many of the city's temples (Bryce 2002).

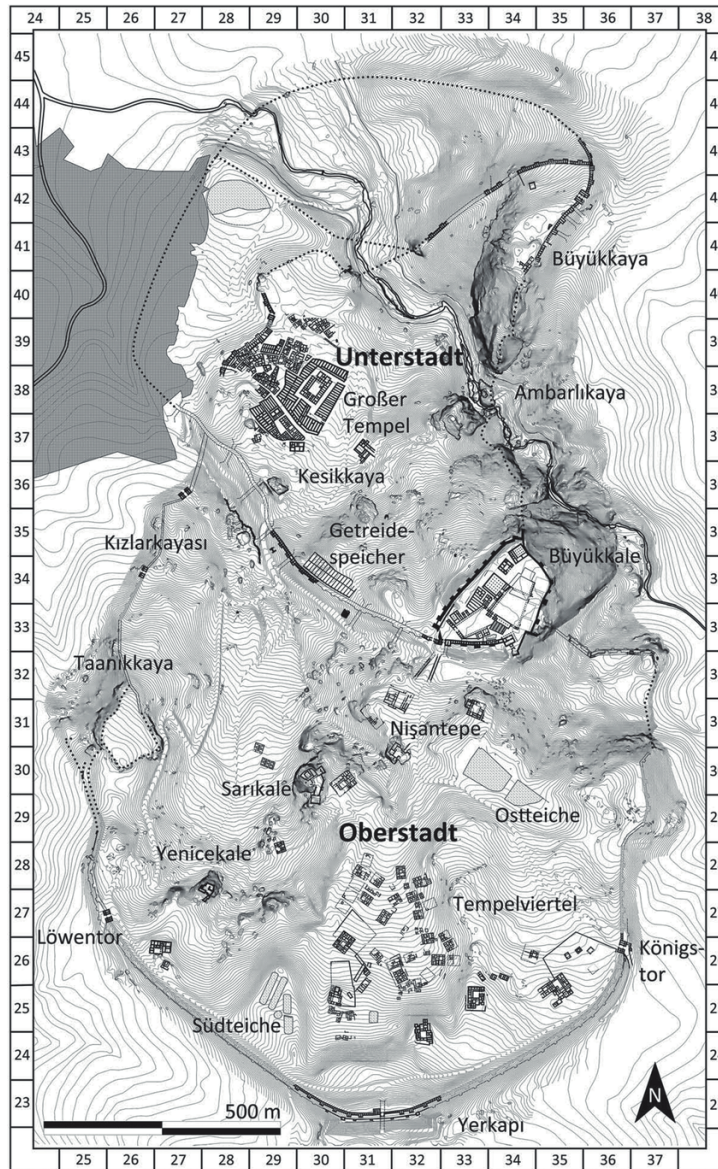


Figure 2.2 Plan of Hattuša. (Harmanşah 2020, Figure 9.2)

### Excavation Contexts

This section focuses on describing the excavation contexts from which the Hattuša faunal materials analyzed in this dissertation (from Kesikkaya Northwest, Kesikkaya South, and the Lower Town South Area, analyzed 2014-2015) were recovered. The excavation contexts of

previously analyzed and published faunal materials at the site, which are used for comparison in Chapter 6, can be seen in Table 2.1.

The Hattuša faunal materials included in the present analysis come from the southern portion of the Lower Town of Hattuša. Work in this area began in 2009 under the direction of Andreas Schachner and has continued since then (Schachner 2010; Schachner 2015). This work complements the earlier excavations in the northern quarters of the Lower Town under the direction of Kurt Bittel from 1938-1957. Recent work in the Lower Town has focused on clarifying the chronological phasing of the city of Hattuša as well as its urban development (Schachner 2015).

Spatially, these recent excavations have taken place in the vicinity of Kesikkaya, a large rock outcropping characterized by a natural cleft that divides the outcrop into two. The limestone from this outcropping was used as building material for some of the structures in the Lower Town (Seeher 2002), and there was once a Hittite structure on top of the outcrop. Kesikkaya may have been associated with a *hekur* (Schachner 2015), a type of Hittite monument located on a mountain peak or stone outcrop (Singer 2009: 169). The excavation area extends from the Early Hittite (16<sup>th</sup> century BC) postern wall to the west (the earliest fortification of the city) to the “Südareal” (or “South Area”) of the Great Temple (Temple 1) (Schachner 2015). The South Area is a large building complex immediately southwest of the temple. The temple itself is the largest structure that has been excavated at Hattuša.

<b>Excavation Area</b>	<b>Zooarchaeological Data Sources</b>	<b>Period(s) Included in Analysis</b>	<b>Description</b>
<b>Büyükkaya</b>	Von den Driesch and Pöllath 2004	Hittite, Early Iron, Middle Iron	The “Great Rock.” a large, rocky outcrop occupied from the 6 <sup>th</sup> millennium BC through the Middle Iron Age; the location of large-scale grain storage in the Hittite empire period; to date, the location of the only Early Iron Age faunal materials excavated at Hattuša
<b>Lower Town (North)</b>	Von den Driesch and Boessneck 1981	Karum, Hittite	Residential area containing the royal acropolis; contains a large number of residences (located north of Temple 1); many of these residences date to the Hittite Empire period
<b>Sarıkale</b>	Hollstein and Meddea 2014	Hittite	Hittite period faunal materials excavated from the valley to the west of Sarıkale (the “Yellow Fortress”) in the Upper City. Materials come from the “Square Building horizon” and date to the late 16 <sup>th</sup> /early 15 <sup>th</sup> centuries BC
<b>Middle Plateau</b>	Berthon 2017	Hittite	A plateau located between Yenicekale and Sarıkale; materials from the 15 <sup>th</sup> through 14 <sup>th</sup> centuries BC come from a large building, the house of the GAL MEŞEDI, “the bodyguards’ chief”; later 14 <sup>th</sup> century materials come from a second building in this area (the “Eastern building”)

Table 2.1 Sources of published faunal materials from Hattuša

The Hattuša faunal materials that are the subject of this analysis come from three separate areas within the southern Lower Town excavations: Kesikkaya Northwest, Kesikkaya South, and the South Area. Results from Kesikkaya Northwest, which is an excavation area northwest of the rocky outcrop Kesikkaya, show that this area was occupied continuously from the Karum period

(MB I) well into the Hittite period, through the early 15<sup>th</sup> century BC. The northern part of this area is dominated by a building the excavators refer to as a “hall house” (Building 90) (Schachner 2015: 67). This building was in use during the Hittite period, until the 15<sup>th</sup> century BC. Below it is a house dating to earlier in the Hittite period. In contrast to the hall house, which contains a hallway, this earlier building is characterized by a central room, an architectural style very common in urban settings in Anatolia from the 3<sup>rd</sup> millennium through Hittite Empire period (Schachner 2015: 68). Below this structure is a building level dating to the Karum period; only disjointed walls were able to be identified here, but it is believed that this level of construction is contemporaneous with a Karum period building (Building 82), located immediately to the southwest. Based on radiocarbon dating, this Karum period building is dated to the second half of the 18<sup>th</sup> century BC (Schachner 2015: 68). Southwest of the Karum period building is a Hittite period house (Building 91) which dates to the early 15<sup>th</sup> century BC.

Concerning the structures uncovered in Kesikkaya Northwest, Schachner (2015: 68) emphasizes their residential character, the lack of monumental architecture in this part of the southern Lower Town, and the continuity of building/occupation here, with newer buildings built directly onto the foundations of older ones. He suggests that the abandonment of this occupation in the area of Kesikkaya Northwest likely coincides with the construction of the nearby Great Temple and was part of a reorganization of the Lower Town at this time as the Hittites became more prominent in the region. He notes that the abandonment of Kesikkaya Northwest would have opened up a sightline toward the monumental Great Temple, visually emphasizing it within the urban landscape of Hattuša (Schachner 2015: 69).

Schachner (2015) writes that the area to the south of Kesikkaya (Kesikkaya South) was not occupied until the Hittite period. Excavations there in recent seasons have revealed a

monumental two-story structure built directly against the face of Kesikkaya. The western edge of this structure is defined by a row (25 m in length) of unadorned orthostats (Schachner 2015: 70). The building was likely constructed during the 17<sup>th</sup> to early 16<sup>th</sup> centuries BC, contemporaneous with the nearby postern wall. Due to the lack of *in situ* finds within the building, it is difficult to know its function, but given its proximity to Kesikkaya (which has its own potential cultic associations), its monumentality, and the unusual shape of part of the building (not seen elsewhere on the site), Schachner (2015: 72) speculates that the building was public and that its function may have been religious in nature.

Middle Iron Age materials from Kesikkaya South come from a large terraced multi-level building complex with substantial stone walls (Schachner 2014: 99-103). This building contained several unusual small finds which Schachner (2014:100-101) argues may have been intentionally deposited: an aryballos-like vessel with few comparands in central Anatolia, an iron knife, and a partial stone mace head. To date, no other Middle Iron Age structures with this kind of monumental scale have been excavated at Hattuša (they were all built on a much smaller scale), and Schachner (2014:103) suggests that the terraced complex likely had a public function.

Finally, faunal materials analyzed for this dissertation come from the South Area. As mentioned above, the South Area is a building complex located adjacent to the Great Temple and is contemporaneous with it. This large complex covered 5,300 square meters and contained store rooms and cult chambers (Seeher 2002:24). Seeher (2002:24-25) notes that “A cuneiform tablet found here mentions a E-GISH-KINTI, that is, a ‘House of Operations,’ tasks in which priests, musicians, singers, and...scribes...were involved. If this concept of a work area applies to the complex as a whole, it must have included workshops and ateliers as well as perhaps living space for the official personnel of the Great Temple.” The South Area was originally excavated during

the first half of the twentieth century, but Schachner (2012; 2015) returned to it as part of the recent southern Lower Town excavations. This work has focused on the foundations of the existing structure, revealing “the existence of architecture on a large scale predating the erection of the surviving monumental buildings” (Schachner 2012:80). The faunal materials included in the analysis come from these deposits, which date to earlier in the Hittite period than the 15<sup>th</sup> century structure associated with the Great Temple.

### 2.8.2 *Çadır Höyük*

In contrast to Hattuša, with its massive fortification wall, palace complex, and dozens of temples, the site of Çadır Höyük (Fig. 2.3) in Yozgat province offers an example of a Hittite provincial town. This rural center, located in the central region of the empire around 60 km Hattuša, is only a fraction of the size of the imperial capital.

#### Site Background

Çadır Höyük is a mound site situated on a natural rise adjacent to the confluence of the Kanak Su and the Eğri Su Rivers in north central Anatolia, approximately 16 km away from the modern-day town of Sorgun (Gorny et al. 1995; Steadman et al. 2007; Steadman et al. 2008; Steadman et al. 2013; Ross 2010). The mound itself covers 4.4 hectares, with base dimensions of roughly 200 x 260 meters; it rises approximately 32 meters above the surrounding valley floor (Steadman et al 2007: 386). The mound overlooks a lower terrace to the northeast (the North Terrace), where occupation spanned approximately 5 hectares (Steadman 2017: 205). Occupation at the site dates from the Middle Chalcolithic (5200 cal. BC) through the Byzantine period, and the settlement was abandoned sometime between 1100-1300 CE (Steadman 2017).

For much of its occupation, the site appears to have served as a rural center (Steadman et al. 2007; Steadman et al. 2008).



Figure 2.3 Çadır Höyük (photograph by author)

### Excavation Contexts

Faunal materials included in the present analysis derive from two excavation areas on the mound: the step trench and trench USS 4. Materials dating from the mid-second millennium BC were recovered from the step trench on the mound's eastern slope (trenches ST 2, ST 3, ST 6, ST 7, ST 8, and ST 9) (Fig. 2.4) (Ross et al. 2019a). This excavation area was originally opened as a 2x20 meter exposure in 1994 in order to collect information on the mound's stratigraphic sequence. A major goal of recent excavation seasons (from 2012 onward) has been to expand

this exposure and our understanding of the site during the second millennium. This work has revealed the outer edge of the second millennium occupation at the site

A series of walls dating to the Karum period (MB I) was uncovered in the step trench near the enclosure wall of the Early Bronze Age occupation (Steadman 2013 et al. 126-127; Steadman 2015 et al. 96-97). These walls include a two-meter wide casemate wall (Ross et al 2019b). This earlier wall serves as the foundation for the more substantial Hittite period fortifications at the settlement, which consist of a large wall with a stone foundation (4 meters wide), topped by mudbrick. This wall was maintained and remodeled over several phases, “attesting to continuous attention to the site’s defenses” (Ross et al. 2019a: 21; cf. Steadman et al. 2015), and pointing toward the presence of “a significant settlement [at Çadır] during the 2<sup>nd</sup> millennium” (Ross et al. 2019a: 21). Just within the Hittite period fortification wall were two rooms dating to the end of the Old Hittite or the beginning of the Middle Hittite period. The rooms were located side by side and were part of a large public structure based their scale and the type of construction (Ross et al. 2019b). Exposure of these rooms was limited to their eastern-most areas. To the east, (the downslope direction) they faced open courtyards which contained pit features (Ross et al. 2019a; 2019b).

Materials dating to the Hittite Empire/Transitional period and the Early and Middle Iron Ages were recovered from trench USS 4 on the mound’s upper south slope (Fig. 2.4). Trench USS 4 measures 10x8 meters and was opened in 2001. One of the main research objectives involving this trench has been to develop a detailed understanding of the Iron Age sequence at the site, beginning with the Late Iron Age and extending back in time (Ross 2010). More recently (from 2012 onward), work in this trench has focused on defining the transition from the Late Bronze Age to the Early Iron Age at the site (Ross et al. 2019a). Thus far, the faunal

materials recovered from this trench offer a continuous sequence from the Hittite Empire/Transitional period (LB II) through the Late Iron Age. The Late Iron Age faunal materials were excluded from the present study, but preliminary analysis of these materials by the author can be found in recent publications (Ross et al. 2019b; Steadman et al. 2017).

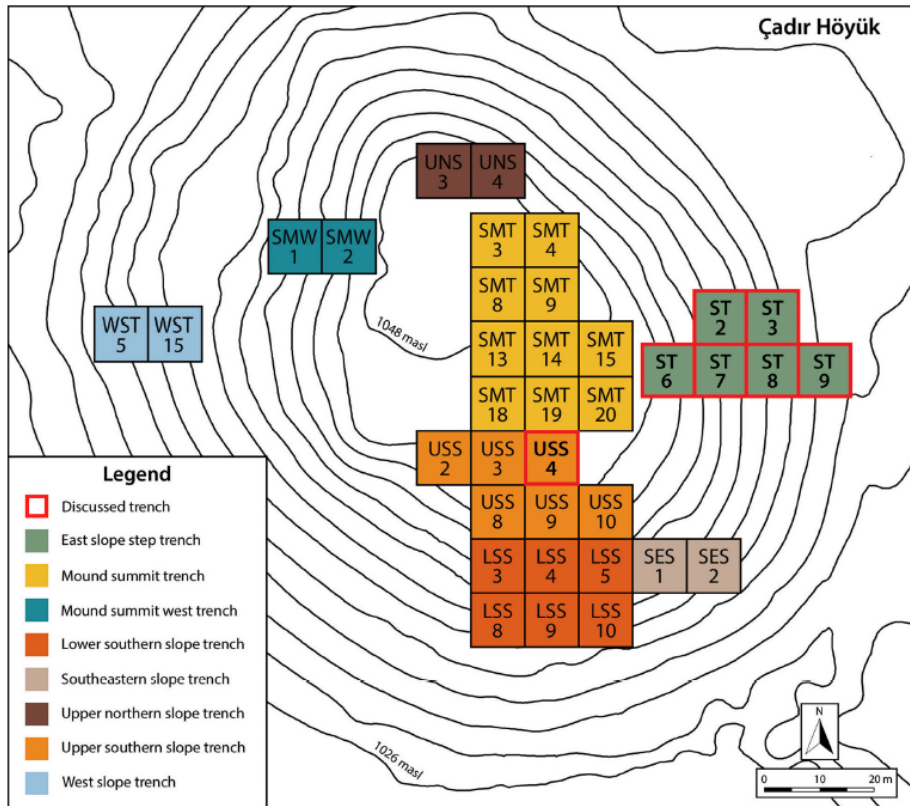


Figure 2.4. Topographic map of Çadır Höyük showing excavation areas, highlighting those mentioned in the text (from Ross et al. 2019a Figure 2)

Excavations on the mound’s upper south slope have revealed two mudbrick walls dating to the second millennium. The first of these was built early in the second millennium on top of the settlement’s Early Bronze Age enclosure wall; the second wall was constructed later in the second millennium. Trench USS 4 contains part of these mudbrick walls. The excavation phase that includes these walls represents the earliest occupation level yet reached in trench USS 4,

dating to the Hittite Empire/Early Iron Transition period, and it contains a series of pyrotechnical installations likely used for metallurgical purposes that were built into the mudbrick of the southern Hittite wall. These installations were rebuilt and reused over multiple phases, and their function may have been to purify copper or a copper alloy (Ross et al. 2019a: 23; Steadman and McMahon 2015: 98-99). Ross et al. (2019a: 23) have suggested that during the Late Bronze Age, this “industrial” area may have had a degree of separation from the rest of the settlement, writing that “[e]phemeral walls near the northern end of the trench may indicate that this area was outside of the LB settlement, or at least isolated from it.” They add that the continued use of this area and its pyrotechnical installations “suggests that the occupation of Çadır continued into the late Hittite Empire, or even after the Hittite collapse, as did characteristic industries” (Ross et al. 2019a: 23).

The Early Iron Age occupation levels in trench USS4 are located above these Hittite Empire/Transitional pyrotechnical installations. The Early Iron materials “consist of deep circular and shallow rectilinear features...which were periodically renewed” (Ross et al. 2019a: 24). There is also a “sloping subrectangular room” with a plastered floor which shows evidence “that a liquid had dried on top of [it]” (Ross et al. 2019a: 24). Although originally interpreted as semi-subterranean houses (Ross 2010), these features are now interpreted as work surfaces. Some of these features were lined with plaster, suggesting an aim of either water retention or keeping water out, and there was a mudbrick lined charcoal storage pit. Features in this area were renewed/restored multiple times during the Early Iron Age phases. The excavators point out that “[w]hile these features are frustratingly elusive as to purpose, they indicate a new use of this space in the EIA” compared to the Late Bronze Age (Ross et al. 2019a: 24). One interpretation is

that this space was used for the processing of wool, including felt-making (Ross et al. 2019a: 25; Steadman et al. 2015: 101).

The Early Iron Age deposits in USS 4 are topped by a fill layer, the nature of which suggests that the area was deliberately leveled in preparation for Middle Bronze Age construction (Ross 2010). Activities in the area continued to focus on animal products, particularly wool-working during this period, but there was a shift to thread and textile production, as evidenced by the presence of spindle whorls and loom weights. Features in the area included paved walkways that connected work areas. There are also “some significant wall sections, including perhaps one arm of a gate whose foundation was stone” (Ross et al. 2019b).

To summarize, the majority of second millennium (Karum period and Hittite period) faunal materials at Çadır come from contexts surrounding the settlement’s outer walls. Meanwhile, contexts spanning the Hittite Empire/Transitional period, Early Iron, and Middle Iron are defined by industrial activity and work areas, though the character of the activities carried out in this area changed over time. None of these excavation contexts appear to be domestic in nature.

## **2.9 Summary**

Through reviewing the social and economic context of the Hittite period and the subsequent Iron Ages in central Anatolia in this chapter, it becomes clear that an underlying narrative has shaped our conventional understanding of the Hittite empire and its collapse. This narrative traces a shift from intensive political and economic centralization during the empire period to political and economic disorder and fragmentation during the Early Iron Age. This is reflected in how the Hittite state is conceptualized, depicted by the general idea that life “[l]ife in

Anatolia under Hittite rule was highly regulated” (Collins 2007: 111) and in the implication that, with the removal of the king’s authority post-collapse, political and economic fragmentation and decentralization ensued in tandem. This narrative, which tends to be based on material and textual evidence from elite contexts and perspectives, can also be seen in the ways in which the relationships between capital and provinces have been discussed, with the Hittite countryside understood as having little autonomy, and in what has been depicted as the top-down organization of Hittite animal economies. At the same time, this tacit understanding has shaped how we interpret the textual and archaeological evidence relating to the Hittite collapse and its aftermath.

### CHAPTER 3 TOWARD A ZOOARCHAEOLOGY OF COLLAPSE

In recent decades, the field of zooarchaeology has grown dramatically, expanding far beyond simple catalogues of what past people ate, and becoming, as Melinda Zeder envisioned in 1991, “a central avenue for arriving at an archaeological understanding of culture change” (255). Given the integration of animals into daily human life (Russell 2011) and thus their general ubiquity spanning time and space, zooarchaeological approaches have proven extremely useful for reconstructing life in past societies (Steele 2015). Since the field began to grow in the 1960s, zooarchaeologists have used animal bone evidence to address a wide array of questions and topics, including domestication (e.g. Albarella et al. 2006; Zeder 2012), the economies of urban and complex societies (e.g. Zeder 1991; Lev-Tov and deFrance 2010), cultural preference and ethnicity (e.g. Stein 2002), ritual and ideology (e.g. O’Day, Van Neer, and Ervynck 2004), and beyond. However, in spite of the vast amount spatial, temporal, and thematic ground covered by the zooarchaeological literature, very little work has been specifically dedicated to addressing questions of societal collapse (the main exception being Emery’s [1997] work on the Maya collapse, see below).

The primary goal of this chapter is to lay out a zooarchaeological approach to the study of societal collapse. The aim is to present a general model for using animal remains to engage with questions surrounding collapse and its aftermath that can be applied in a variety of times and places. It is generally acknowledged in zooarchaeology that the past practices animal remains represent operate simultaneously at multiple scales, from the local to the institutional. Thus, they offer a potential bridge between daily practices and overarching organizational structures. Consequently, I argue that animals and their remains can serve as a lens for understanding how

people in different places and situations were impacted by an empire's collapse and how they responded. In the Hittite case, for example, what did it mean for the people of rural Çadır when the empire lost its coherence? Were their lifeways disrupted, and if so, how did they react? Likewise, how did these events affect daily life at the capital?

In setting up this kind of analytic framework, it is first necessary to consider our broader scholarly understanding of what societal collapse is and how it functions. The chapter thus begins with a review of the anthropological and archaeological literature on societal collapse, specifically focusing on the underlying conceptualizations of society embedded in frameworks of collapse which find their origins in social evolutionary theories and systems thinking. This in turn allows for greater insight into the common narratives of collapse introduced in the first chapter of the dissertation, for example, the idea that collapse signals “the end” of a society. In this section, I push back against conceptualizations of collapse that imagine the polity as a totality that will inevitably collapse in its entirety, and I present a way forward that builds on recent framings of collapse that have emphasized the importance of continuity and studying the social processes that occur after collapse, arguing for the usefulness of approaching collapse as process rather than final event.

The final part of this chapter then turns to a “zooarchaeology of collapse,” which is presented as a way to mobilize the discussion of “high level” theory. In essence, this section presents zooarchaeology as a way of linking between broad understandings of collapse and the minutiae of the archaeological data. It makes the argument that, in order to understand the processes involved in collapse and what comes after, we have to know what things were like before. If the goal here is to understand how animal economies did (or did not) shift post-collapse and the implications of this evidence (i.e. how to interpret people's post-collapse

decision-making), we have to first develop a baseline understanding of animal economies in a given society pre-collapse. Post-collapse data can then be compared to this baseline. Critical in this analysis is paying close attention to context to aid in interpretation, both in terms of excavation context and the social/historical context in which the evidence was produced. This approach allows not only for a deeper understanding of local responses to collapse in particular times in places, but it also provides us with the tools to critically examine common narratives of collapse and how collapse *should* work.

To facilitate the discussion of zooarchaeology and its value to collapse studies, this section presents four case studies from the zooarchaeological literature on complex societies. Each of these cases uses the analysis of animal bone materials in order to make arguments about societal reorganization in a given time and place following a societal collapse. As will become apparent, one of the things held in common in these analyses is a close attention to archaeological context in order to aid in interpreting the animal bone evidence pre- and post-collapse. In general, these cases have not been framed by their authors as explicit studies of societal collapse – instead the aim is generally to characterize animal management and use in a particular complex society. However, given that a particular skill of zooarchaeologists (and archaeologists more generally) is tracking change over time, the kind of diachronic study demonstrated in these cases lends itself quite well to the study of collapse and how people across time and space have responded to it. In the vein of Schwartz and Nichols (2006), the focus is identifying changes and continuities in the archaeological signatures pre- and post-collapse, and on using the social/historical/economic context of materials to consider what these signatures might indicate about changes and continuities in social and economic organization post-collapse.

### 3.1 Social Evolution, Systems Theory, and Societal Collapse

Discussions of collapse in the ancient world over the past few decades have often framed large-scale political fragmentation in terms of evolutionary arguments about social change. Near Eastern and anthropological archaeologists have for many decades been caught up with questions relating to evolutionary trajectories, the emergence and the development of ‘complex societies,’ and the ‘rise of the state’ (e.g. Flannery 1972; Service 1975; Earle 1997; Feinman & Marcus 1998). Consequently, collapse has been theorized in relation to its supposed place within social evolutionary paradigms. This is exemplified by both of the major works (Tainter 1998; Yoffee and Cowgill 1988) that serve as the foundation of contemporary collapse studies. For example, a major goal in Yoffee and Cowgill’s (1988) seminal volume on collapse is “...to consider some aspects of social evolutionary theory through a limited set of case studies of the collapse of systems of ancient states and civilizations” (Yoffee 1988:2). And, in his influential volume on the subject, Tainter (1988:4) defines collapse as “a rapid, significant loss of an established level of sociopolitical complexity.” Likewise, Yoffee (1988:2; 2005:132) has long placed collapse in relation to the rise of states. “Collapse studies,” he writes, “...yield fresh perspectives with which we may evaluate the conditions of rise” (Yoffee 2005:132). In essence, such approaches present collapse as a mirror to state rise—the disintegration of the components that held the state together and allowed it to function—the devolution of the state.

The idea of collapse as devolution is reflected in the defining characteristics archaeologists have come to associate with societal collapse and which have frequently appeared in the literature over the past several decades (e.g. Renfrew 1984: 367-369; Schwartz 2006: 5-6). These inter-related factors, which include, but are not limited to, political fragmentation, decreased centralization, and the breakdown of regional economies all describe what is

essentially the same phenomenon – the breakdown of a whole into its constituent parts. This “breakdown” relates back to the evolutionary approach through the conceptualization of society as a system. While evolutionary and systems approaches are not the same thing (for example, social evolutionary approaches emerged in the latter half of the nineteenth century, and systems theory appeared approximately a century later), they have been closely intertwined in discussions of social complexity—both in terms of its development and its collapse—for much of the past half century.

Systems theory, which asserts that systems (social or otherwise) consist of interrelated and interdependent parts (e.g. Miller 1965), was introduced to archaeological thinking by the New Archaeologists of the 1960s (e.g. Binford and Binford 1968; Clarke 1968; Flannery 1968). As part of this movement, systems thinking became a key part of how social evolution, particularly the evolution of the state and of complex societies more generally, came to be understood by archaeologists in the latter half of the twentieth century, and it continues to (consciously or unconsciously) influence archaeological thinking today. In his classic essay, “The Cultural Evolution of Civilizations,” Flannery (1972) argues that society, along with its evolutionary development, can be understood as “one class of living system” that functions according to “a general model” (409). Regarding the state, he writes that “...the state appears as a very complex system, one whose complexity can be measured in terms of its segregation (the amount of internal differentiation and specialization of subsystems) and centralization (the degree of linkage between the various subsystems and the highest-order controls in society...)” (Flannery 1972: 409). An understanding of the rise of the state, therefore, “centers on the ways in which the processes of increasing segregation and centralization take place” (Flannery 1972: 409).

If, according to systems thinking in archaeology, the rise of the state – that is, its evolution – is characterized by “increasing segregation and centralization,” it stands to reason that, from a systems perspective, the fall of the state – its devolution or collapse – would be characterized by the opposite. We can see echoes of the idea of decreasing segregation and centralization in the defining characteristics of collapse mentioned above. The connection becomes even clearer with a closer look at archaeologists’ definitions of collapse over the past four decades. Renfrew (1984: 367-369) made an exhaustive list of the characteristics of societal collapse, which can be summarized as the “[c]ollapse of central administrative organisation of the early state” (367), the “[d]isappearance of the traditional elite class” (368), the “collapse of [the] centralised economy” (367), and “settlement shift and population decline” (367). Renfrew’s criteria have often been echoed by others and can be taken as fairly representative of what often appears in the subsequent collapse literature (Middleton 2017b). For example, in *After Collapse*, Schwartz (2006: 5-6) associates collapse with political fragmentation, the abandonment of urban centers and a loss of centralization, the breakdown of regional economies, and the failure of ideological structures. And, in his recent effort to enable an understanding of collapse, Middleton (2017b: 18), writes: “...frequently, collapse is used to mean the fairly rapid ending of states (including empires and much smaller entities), which itself can involve fragmentation into smaller units, simplification of political and social systems, change in urban settings, redistribution of population in the landscape, and changes in ideology made visible in architecture and the arts.” Though these three sets of defining factors span decades, they share an inversion of Flannery’s emphasis on segregation and centralization.

Coming out of systems theory, these definitions taken together point back to a conceptualization of the state or polity as a totality consisting of interconnected parts that can

only function together as a whole. The emphasis is on massive scale systemic inter-dependence; thus, when one aspect of the social system stops functioning “properly,” a domino effect is initiated--ultimately collapse occurs, and the state falls apart in its entirety. Cline (2014a) touches on this idea in his discussion of the region-wide collapse at the end of the Late Bronze Age across the Eastern Mediterranean. Using a mechanical metaphor to make his point about complex social systems, he writes, “Here is where a malfunctioning cog in an otherwise well-oiled machine might turn the entire apparatus into a pile of junk just as a single thrown rod can wreck the engine of a car today” (Cline 2014: 168). To return to Flannery’s (1972) argument, the idea is that complex societies reach a point in their evolutionary development when the various parts that allow them to function (for Flannery, their institutions) become completely dependent on one another, a state Flannery refers to as hypercoherence. At this point, “when an individual institution suffers stress, it negatively affects all of the other interdependent institution, causing the breakdown or collapse of the hierarchical organization of the system” (Faulseit 2016: 10).

This logic, which underlies evolutionary and systems approaches to collapse, suggests a reason why collapsed states can be declared to have failed, both in terms of the archaeological literature (e.g. Tainter 1988; Railey and Raycraft 2008; Johnson 2017) and in contemporary ‘failed state’ rhetoric (e.g. Boyes 2014; Acemoglu and Robinson 2012). It also reveals some of the theoretical underpinnings as to why, in evolutionary frameworks, states can experience a rapid decrease in complexity (Tainter 1988:4), since the failure of the system results in a dismantling of the building blocks brought together by the evolution of the state.

Moreover, an extension of this logic would suggest that the collapse of the state would result in a reversal to prior social forms and lifeways. This idea is reflected in Anatolian archaeology, where it is often assumed that with the collapse of the Hittite empire and the

subsequent removal of its political superstructure, there was a subsequent return to a sort of trans-historical “traditional Anatolian” lifeway. The assumption here is that it is only during exceptional historical moments/periods (such as the rise of the Hittites to prominence in Anatolia in the latter half of the second millennium) that the basic rhythms of life in Anatolia truly changed – and that these changes were only temporary.

In a social evolutionary schema, the breakdown of the state as system—or its collapse—is manifested by a return to earlier forms of development. There’s a way in which, within this framework, the state becomes represented almost as a matryoshka: embedded within a state-level society are elements of previous evolutionary forms as well as the potential to revert back to them. Thus, when the state collapses there is a “devolution” to earlier evolutionary stages/older social systems as the “newer” social structures fall away.

Social evolutionary theories such as those proposed by Flannery (1972), Service (1975), Earle (1997), and Feinman and Marcus (1998) have come under strong critique in recent years. Likewise, systems approaches have become less popular in archaeology. For example, Hodder and Hutson (2004) have written that general systems theory ignores human action and historical specificity and is too concerned with “abstract notions of structures and organizational mechanisms” (Faulseit 2016: 11). Regarding evolutionary theories of social change, Pauketat (2007) has criticized the concept of the chiefdom, a key component in many theorizations of social evolution. Yoffee (2005) has deconstructed previous approaches to social evolution, arguing against linear theories of social development and instead for multiple trajectories to “complexity.” And Chapman (2003) has rejected the concept of complexity entirely, suggesting that it is an Anglo-American product of the Enlightenment, “a kind of shorthand...for focusing

on societies which are more like ‘us’” (7). He further notes that “...the criteria that we use to identify changes – such as the emergence of complex societies – in the past are chosen in the present, in historically determined contexts” (Chapman 2003: 7). Chapman’s assertion that archaeological frameworks are closely intertwined with our contemporary socio-historical situation aligns well with the discussion of presentism in Chapter 1.

These varied critiques have serious implications for how we should think about societal collapse, which has frequently been presented as an inversion of social evolution and in terms of massive systemic failure. At the same time, social evolutionary and systems thinking continue to influence and shape the discipline of archaeology today, and they remain embedded in collapse studies. For example, in his recent book *Why Did Ancient Civilizations Fail*, Johnson (2017) suggests that societies fail because “they cannot see that *the systems supporting their way of life are linked together*” (emphasis mine). As we attempt to understand what are often conceptualized as “failed” societies, it is critical to keep in mind the underlying logics that determine how a polity can be said to have failed in the first place.

### **3.2 Narratives of Collapse and Its Aftermath**

The implicit conceptualization of society as system/totality which can ultimately “fail,” has deeply shaped how the process of collapse has been narrativized by archaeologists. This understanding of how collapse works has resulted in an overarching narrative of collapse that presents collapse as “the end” of society. However, as we’ll discuss below, this narrative is one that has come under strong critique in recent years, as the archaeological literature on collapse has come to emphasize themes such as continuity, reorganization, transformation, and resilience (e.g. Schwartz and Nichols 2006; McAnany and Yoffee 2010; Faulseit 2016).

As we've noted, the defining factors of collapse that appear in the literature – e.g. political fragmentation, the abandonment of urban centers “and depletion of their centralizing functions” (Schwartz 2006: 6), as well as the breakdown of regional economies – all amount to the same thing: the breakdown of a whole into its component parts. Practically speaking, this has resulted in an understanding of collapse that assumes a shift from centralized to decentralized in almost every possible sense – in terms of political power and influence, economic organization, and population dispersal/the abandonment of urban centers.

In the literature on the Hittite collapse in central Anatolia, we see these ideas presented in a common narrative that presents a shift from centralized to decentralized political and economic organization following the empire's collapse. This narrative, which also tends to be reflected in the broader collapse literature, consists of two closely interwoven threads. *First, it assumes a degree of political and economic integration and interdependence such that when an empire's political systems collapse, its economic systems must also fail.* Conceptually, the first narrative thread finds its origins in systems theory (cf. Flannery's [1972] hyper-coherence model, Rappaport's [1977] over-segregation model, and Renfrew's [1984] emphasis on over-specialization). As discussed above, from this point of view, the process of collapse involves the fragmentation of a society into its component parts. For example, a state that once governed a large politically and economically integrated territory may split into multiple, smaller polities that then vie for regional dominance (Renfrew 1984). From this perspective, in the aftermath of collapse, a given society takes on political and economic aspects that are more decentralized than they were previously. In the Hittite case, it is typically assumed that the Hittite empire had a relatively strong degree of political and economic organization (as evidenced, for example, by a massive capital city, large-scale grain storage, and taxes taken in kind), and that subsequent

reorganization post-collapse resulted in greater political and economic decentralization (e.g. lack of a centralized political authority; focus on localized subsistence production rather than commodity production intended for regional trade) (see Chapter 2). Elsewhere in Near Eastern archaeology, we see this relationship between political and economic centralization documented in the Ur III context in Mesopotamia, where the bala tax system disappears when the Ur III state starts to decline (Sharlach 2004: 163).

A second, possibly contradictory, narrative thread *assumes a differential integration of urban centers and rural sites in the empire's systems of organization, which entails that smaller sites are less affected by the empire's collapse, since they were less firmly embedded in its political and economic systems in the first place.* The idea here is that, while the impacts of societal collapse on urban centers (such as Hattuşa, which was largely occupied by elites) would have been devastating, daily life would have continued much as usual for individuals living in more rural areas. As Tainter (1999: 736) writes, “What may be a catastrophe to élites and administrators need not be to most people.” Likewise, Middleton (2017b: 94) has asserted more recently that “...the lifeways of the majority may be most likely to survive a collapse.” This narrative thread, which, in the Hittite case, has a tendency to focus on differential effects grouped by site size (the assumption being that rural sites are filled with the “common man”), seems to derive in part from models of inter-regional interaction based on multi-tiered site hierarchies (e.g. Wright and Johnson 1975).

Within these narratives, there are separate ideas about the state and the nature of the state's power that are operating in tension. First, there's an assumption of large-scale regional integration – assuming, in effect, an equal distribution of the state's power and influence, across time and space. At the same time, there is a general sense that “commoners” and smaller, more

rural settlements will be largely unaffected by the state's collapse relative to the central regions, presumably because they were never well-integrated in the first place. This narrative thread assumes that the power of the state is limited and unevenly distributed, which is in tension with the idea of the state as a totality. In grappling with these narratives and putting them in dialogue with the zooarchaeological data surrounding the Hittite collapse, the goal of this work is to use zooarchaeological evidence to think through (and possibly against) these two narrative threads. One way of approaching this has been to engage with work that has focused on defining the processes of social reorganization and regeneration that occur after collapse.

The study of collapse came to the fore in archaeology with two major volumes published in 1988 (Tainter 1988; Cowgill and Yoffee 1988). However, it was not until nearly twenty years later, with the publication of *After Collapse: The Regeneration of Complex Societies* (Schwartz and Nichols 2006) that the post-collapse processes became a major focus of archaeological analysis. This having been said, even in his early volume on collapse, one of Norman Yoffee's strongest arguments is that "what happens after collapse is as important as the process of collapse itself" (Yoffee 1988:7). This is because, he argues, the destruction of the disintegrating polity is almost never total, and, depending on the circumstances, aspects of prior social, economic, and ideological structures tend to be retained even in the face of dramatic social reorganization—"[not all] institutions fail" (Yoffee 1988:7). In *After Collapse*, Alan Kolata (2006:209) takes this notion one step further, asserting that "...the conditions of possibility for the social regeneration of complexly structured societies, as well as the specific character of that regeneration, are directly dependent upon the principles and structures of government prior to collapse." In other words, what came before and what comes after are closely intertwined, and

one might even argue, interdependent. This perspective has had a strong influence on the zooarchaeological approach to collapse outlined below.

### **3.3 Toward a Zooarchaeology of Collapse**

In attempting to think both with and potentially against the collapse narratives described above, the literature on the zooarchaeology of complex societies becomes particularly useful. DeFrance (2009) writes that “[a]ll ‘animal choices’ in past societies—economic utility, food, or symbolic uses—were embedded in wider social, environmental, and technological contexts” (145). Consequently, studying changes and continuities in a society’s “animal choices” both pre- and post-collapse can provide insight into how these contexts are organized. In particular, the literature on the zooarchaeology of complex societies argues that political centralization, widely considered to be a key aspect of complex societies (e.g. Flannery 1972; Service 1975), results in a number of features that have the potential to be identified and characterized through the study of animal remains. These include specialized economies focused on surplus production and the creation and maintenance of specialized provisioning systems (e.g. Zeder 1988; 1991; Arbuckle 2012), large-scale social stratification, (e.g. Wattenmaker 1998; Stein 2001); and the collection and central administration of surplus (e.g. Stein 1987; Atici 2005). Studying animal economies pre- collapse and post-collapse thus offers insight into the changing structures of the broader contexts referred to by deFrance.

Moreover, the past practices that produced archaeological animal remains operated simultaneously at multiple scales, from the local to the institutional (cf. Chazin 2016). Thus, they offer a potential bridge between daily practices and overarching organizational structures. In addition, given that human relationships with animals are not merely economic or “functional”

but also symbolic and ideological (Russell 2013), faunal evidence can provide a window into aspects of social life we might miss otherwise. In short, as Claude Levi-Strauss (1963: 89) would have it, “Animals are good to think.”

In spite of the potential that zooarchaeology holds for contributing to our understanding of the processes involved in societal collapse and its aftermath, to date very little work exists that explicitly applies the study of animal remains to the study of societal collapse. The main exception has been the zooarchaeological work of Kitty Emery (1997; 2004) on the Maya collapse. Emery’s work focuses primarily on using zooarchaeological approaches in order to assess potential causes of the Maya collapse. The approach I lay out here instead focuses less on identifying causes and more on defining on the ground responses to the social, political and economic changes brought that accompany societal collapse. Moreover, this approach focuses on identifying and tracing changes over time.

The pages that follow lay out four very different case studies where animal remains are mobilized to address societal collapse. Each of these cases presents the analysis of animal bone materials in order to make arguments about societal reorganization in a given time and place following a societal collapse. They share a close attention to detail, both in terms of the zooarchaeological data and the broader archaeological and historical context, in order to aid in interpreting the animal bone evidence pre- and post-collapse. Further, the cases highlight a number of themes that relate to societal collapse as discussed above, including specialization, provisioning, and centralization. When taken together, these case studies point toward how the thing we call collapse is not uniform – and that paying attention to both the data and the archaeological context is key in making interpretations.

### *3.3.1 Teotihuacan, Basin of Mexico, ca. 150 BC – AD 1500*

The pre-Hispanic city of Teotihuacan functioned as a major urban center in central Mexico in the first half of the first millennium A.D. It is generally recognized that the large population of the site at this time (approx. 100,000 people) resulted in significant changes to the environment around the site. Before the city rose to prominence, people in the Basin of Mexico relied on deer as a major resource, but, as a result of overhunting, “they were less commonly encountered during the Teotihuacan era, replaced by a broader spectrum of smaller animals” (Somerville et al. 2016: 3). A recent study by Somerville et al. (2016) has taken a closer look at the exploitation and management of one such group of small mammals at the site for a period spanning over 1600 years, from the settlement’s earliest development during the Formative period, to its eventual collapse during the Post-Classic.

Excavations at Oztoyahualco, a residential complex at Teotihuacan, dating to the Classic period when the site had reached its greatest extent, have revealed a high proportion of leporid (jackrabbit and cottontail) remains (almost 50% of the assemblage total), many of which showed evidence of butchery. In addition, an unusual rabbit sculpture was found in this area, and excavators identified a space which may have been used as an animal pen (Somerville et al. 2016: 3). It was hypothesized that the leporids from Classic period Oztoyahualco had been actively managed by people living in this area of the site. In order to test this hypothesis, carbon and oxygen stable isotope analyses were conducted on a sample of the leporid specimens to provide insight into the rabbits’ diets. This sample was compared with specimens from other areas of Teotihuacan from the Formative, Post-Classic, and modern periods. Results showed that, unlike those from other periods, the specimens from Classic period Oztoyahualco had isotopic signatures consistent with the “high consumption of plants such as maize, maguey, nopal, and

amaranth” (Somerville et al. 2016: 16), indicating that these animals were likely being directly fed and managed by humans. This strategy, it is suggested, “...could have served as a means to channel surplus ... agricultural products to provision cottontails and jackrabbits, effectively converting excess carbohydrates into high quality protein and economically valuable secondary products, such as fur, hide, glue, and bones for tools” (Somerville et al. 2016: 16). This approach was likely especially valuable given the unavailability of larger mammals (i.e. deer) due to the results of urban population aggregation during the Classic period. Moreover, it is important to note that, as the population of the city began to decrease in subsequent periods, evidence for leporid management disappears (Somerville et al. 2016).

Here we see intensified, perhaps specialized, rabbit management at Classic period Oztoyalco, a choice in animal management that, as Somerville et al. (2016) point out, would have been extremely beneficial in providing this densely populated urban settlement with meat and other animal products. The disappearance of intensive leporid management after the Classic period points toward changes in how animals were managed and exploited at the site post-collapse, suggesting that the intensive exploitation of rabbits at the site was no longer necessary, or no longer desired.

### *3.3.2 Cahokia, American Bottom, ca. A.D. 1020 – 1300,*

As with Teotihuacan, the people living at Cahokia, a massive pre-historic mound site in southern Illinois, faced the challenge of feeding a large population. During the Lohmann phase of the Mississippian period (A.D. 1050-1100), the settlement developed rapidly, experiencing a massive population increase that was accompanied by status differentiation and large-scale public ritual feasting events (Pauketat 2004; Kelly and Kelly 2007: 120). These social changes

were accompanied by “...changes in how some animals ... may have been viewed and used” (Kelly and Kelly 2007: 120).

Before this time, during the Emergent Mississippian, people at Cahokia relied heavily on fish and small mammals which could be acquired in the immediate vicinity of the site. Reliance on maize agriculture limited the amount of time that could be spent hunting, and the sedentary nature of Cahokian society at this time meant that nearby resources – such as large game animals – were easily depleted (Kelly 2000). The larger mammal remains that are present at the site from this time – namely deer – appear to have been brought to the site from further away given that most of the remains came from only “high and mid-utility” parts. These parts of the animal (e.g. forelimbs and hindlimbs) would have yielded the most meat and that would have been brought back to the site after the animals were butchered in the field where they had been hunted, while “low utility” parts (e.g. feet, typically considered to be butchery waste) would have been left behind.

When Cahokia began growing during the Lohmann phase, however, the percentage of fish in the Cahokia assemblage drops dramatically and is accompanied by a huge spike in the percentage of deer. Kelly (2000) hypothesizes that reliance on deer increased because of the growing need for more meat to feed the burgeoning population. Deer, she writes, “...could feed people more efficiently. But, for more deer to be procured, the elite would have had to control wide-ranging hunting territories or a tribute system would have had to have been in place whereby deer meat could be obtained” (Kelly 2000: 78). In other words, deer meat would have had to have been brought to the site from further away.

The analysis of deer skeletal parts from this phase remains heavily skewed toward high and mid-utility parts, providing evidence for provisioning at the site. Given the high proportion

of deer remains at the site during this time relative to other taxa, this provisioning seems to have become a major aspect of food procurement at Cahokia. These patterns of growing reliance on deer meat and on higher utility deer parts only intensify in the subsequent Stirling phase, the period long associated with Cahokia's greatest influence in the region; during this phase, deer comprise over 90% of the site's faunal assemblage (Kelly 2000).

The population at Cahokia began to decrease during the Moorehead phase (A.D. 1200-1275), near the end of the Mississippian period. While excavations have shown that intense ritual activity continued at the site at this time, the population began dispersing outward to surrounding sites (Brown and Kelly 2000). The faunal signatures change as well (Kelly 2000). The proportion of fish and terrestrial birds in the faunal assemblage increases, suggesting a growing reliance on animals that could be accessed nearby. Meanwhile, the proportion of low utility index deer parts recovered at the site increases. This evidence "...may indicate that the site was not being provisioned with as much deer meat; that deer were more scarce, requiring more of the carcass to be returned to the site; or that individuals may have been acquiring deer meat closer to the site" (Kelly 2000: 87). This faunal evidence dovetails with evidence for more localized wood use at the site during this time, when inhabitants began exploiting less "desirable" species of wood from tree stands near Cahokia.

Thus we see that changes in social organization in and around Cahokia spanning the first half of the first millennium A.D. are associated with shifts in the use of animal resources around the site. The needs of the site's growing population during the Mississippian period are reflected in the species exploited (eventually dominated by large-bodied deer) and in distributions of skeletal parts, which show that the site was being provisioned by meat-rich, "high utility" parts.

As the population of Cahokia began to decrease at the end of this period, we see patterns shift away from signs of intensive meat provisioning.

### *3.3.3 Settlements in the Khabur Basin, Upper Mesopotamia, ca. 3000-2000 BC*

The Early Bronze Age in northern Mesopotamia was a time of increasing urbanization (e.g. Oates et al. 2007; Wilkinson et al. 2007). During this time, sites in the Khabur basin relied on rain-fed agriculture, as opposed to the irrigation-based agriculture systems employed by their neighbors in southern Mesopotamia, where the annual amount of rainfall was inadequate to support crops. It has been argued that the end of this period coincides with an environmental collapse – a change in climate that Weiss (2015) has called a megadrought (also referred to as the 4.2 ka BP climatic event). This drought, Weiss (1997) asserts, affected the amount of rainfall in the region, meaning that the Khabur basin could no longer sustain agricultural production at the end of the Early Bronze Age. Consequently, around 2000 BC, this drought resulted in changes in local lifeways and in the abandonment of many sites in the region. The environmental and economic impacts of this climatic shift, and the associated collapse of large settlements in the upper Khabur basin, can be glimpsed through the faunal record, but the outcomes are not necessarily what we would expect.

Drawing on work by Zeder (2003) and Dobney et al. (2003), Grigson (2007) synthesizes evidence from multiple sites in the region during this period as part of her review of the culture and ecology of pigs around the Fertile Crescent from the 5<sup>th</sup> through 3<sup>rd</sup> millennia BC. Pigs, she notes, have certain physiological limitations, requiring a wet environment and shade to survive (Grigson 2007: 98-99). Surveying reports from across the Levant and Mesopotamia, Grigson asserts that, during the 5<sup>th</sup> (Early Chalcolithic) and 4<sup>th</sup> (Late Chalcolithic) millennia, the presence

or absence of pigs at sites across the region, including the Khabur basin, tracked with aridity, with pigs largely absent in areas too arid for dry farming (Grigson 2007: 101). She writes that, during these periods “there are no variations in pig numbers that can be attributed to cultural rather than environmental factors” (Grigson 2007: 101).

At the end of the third millennium, one might expect this trend to continue—as the climate around the Khabur entered an intense dry period, we would expect the proportion of pigs at sites in the region to decrease as the climate became too dry for them. This is indeed the case at Tel Atij and Tel Raqa’i, two smaller settlements in the Middle Khabur basin. At these sites, pigs comprised 20% or more of the overall faunal assemblages during the earlier part of the Early Bronze Age, but by the end of the period, they are almost completely absent (Grigson 2007). Interestingly, at two major sites on the Upper Khabur, Tel Brak and Tel Leilan, pig frequencies remain high. Grigson (2007: 105-106) argues that the reason for this is that “...these were very large urban sites in which pigs were not only provided with shade from buildings, but also sustained by scavenging urban rubbish, so providing food for the inhabitants as well as removing refuse.” Moreover, at Leilan, Zeder (2003:176) notes that pigs make up almost fifty percent of the identifiable fauna from the lower town, which was dominated by non-elite residences; the elite upper town, on the other hand, was dominated by caprines. In this way, she writes, “...Leilan joins a growing number of urban sites in which lower-status residents seem to have been directly involved in raising pigs for their own consumption,” and she adds that “...locally produced swine would have given these households a reliable, low-labor-intensive, highly productive source of meat” (Zeder 2003: 176). Also interesting is the fact that, of the pigs that were found in the elite upper town at Leilan, a high proportion were very young individuals,

suggesting an elite preference for suckling pigs, likely provisioned by non-elite residents in the lower town (Zeder 2003; Grigson 2007).

Thus, in the case of the Khabur basin at the end of the Early Bronze Age, we see the convergence of multiple factors that can affect interpretation. The frequencies of pigs leading up to the Early Bronze Age collapse and ultimate abandonment of sites in the Khabur Basin reflect the dramatic climatic shifts that were taking place at the time and the physiological tolerances of animals to cope with these changes. Simultaneously, however, they reflect the intersection of these factors with urbanism, social status, and economic organization/provisioning patterns.

### *3.3.4 Roman Period in Britain and Subsequent Retreat, ca. A.D. 50 - 600*

This case study on the faunal remains associated with the Roman retreat from Britain is drawn from a recent study by Rizzetto et al. (2017), which was conducted using materials from nine sites in central-eastern England. I specifically focus here on changes associated with cattle management after the “fall” of Roman Britain. Rizzetto et al. (2017) note that, generally speaking, the Roman period occupation in England is associated with intensive cattle husbandry. Cattle were relied upon heavily for traction and for producing large amounts of meat. Based on biometric data, the cattle found at Roman period sites are a large, “improved” variety, which would have helped to facilitate an economic system based on surplus production (Rizzetto et al. 2017: 551).

Moving into the Early Anglo-Saxon period, after the Roman retreat from Britain, Rizzetto et al. (2017:536) point out that that production strategies in England begin to become much less standardized and “that the character of animal husbandry [at this time] was dictated by the needs of local, self-sufficient communities and by environmental constraints.”

Simultaneously, Rizzetto et al. (2017) show that the overall size of the cattle during the Early Anglo-Saxon period decreased, becoming more gracile. In interpreting this size change, they write that “[p]erhaps the improvement of livestock required a range of skills and resources which were no longer available or selected for” (Rizzetto et al. 2017: 548). On the other hand, they argue that “...it is possible... that improved livestock was simply not needed by early Anglo-Saxon settlers” (Rizzetto et al. 2017: 548), who were much more focused on small-scale meat production and exploiting a variety of secondary products.

The case of cattle exploitation in England in the Roman and medieval periods is interesting in several ways as it relates to the intersection of collapse and animal management. First, we see a reduction in cattle size moving into the medieval period, potentially reflecting both a decrease in specialization and a change in the regional population. Second is the emphasis that Rizzetto et al. (2017) place on the impacts of local decision-making as they highlight how the animal management systems of Anglo-Saxon settlers may have not had a need for large, improved cattle, and that the choice to breed smaller animals may have been deliberate, not simply the result of a “decline.”

### *3.3.5 Case Studies: Conclusions*

These four zooarchaeological cases cover a large amount of ground, temporally, spatially, and thematically. However, taken together they highlight several key themes worth emphasizing as we begin to imagine what a zooarchaeology of collapse might look like. Following Zeder (1991), they emphasize the association between complex societies and specialization and provisioning systems (e.g. at Teotihuacan and Cahokia). Moreover, they show how, post-collapse, these systems can be reorganized in a variety of ways. In the simplest terms,

these processes of reorganization can be read as simple directional shifts, from centralized to decentralized organization, or specialized to non-specialized production, or direct to indirect provisioning. However, these cases also point out the complexity of social change and the need to account for departures from expected models. For example, in the case of the Khabur, we see the signatures of pig management intersecting with multiple factors—climate, urban vs. non-urban, and elite vs. non-elite status. In early Anglo-Saxon England, we see changes that might be read as a loss of skills associated with specialization, but that could be interpreted as a deliberate choice in the face of changing needs. These cases point to the value that zooarchaeological work can provide to studies of collapse, but they also point to a need to listen to the zooarchaeological data and to accept that our results may not fit well within the constraints of traditional collapse narratives.

### **3.4 Final Thoughts**

This chapter has considered the predominant narratives surrounding collapse in the ancient world and how zooarchaeology can engage with them. Zooarchaeology is a powerful tool for understanding on the ground responses to societal collapse and can allow us to critically examine the narrative assumptions embedded in our conceptualizations of collapse and its aftermath.

Coming out of this discussion, a key consideration moving forward is the need to be cognizant of these narratives and how they can shape our expectations and interpretations of the archaeological data. In interpreting the archaeological data, it is critical to allow the data to shape the narrative and not the other way around. To this end, the chapter that follows will expand on this discussion by focusing on middle range theory, bridging the gap between high level theory

and archaeological practice, and setting up a framework for placing the zooarchaeological data from Bronze and Iron Age Hattuša and Çadır in dialogue with these broader collapse narratives.

## **CHAPTER 4**

### **METHODOLOGICAL AND INTERPRETIVE APPROACHES TO THE HITTITE COLLAPSE USING ANIMAL REMAINS**

The goal of this chapter is to lay out the methodological and interpretive approaches (i.e. middle range theory) that were used to examine the faunal evidence from Hattuša and Çadır Höyük from the Middle to Late Bronze through the Early to Middle Iron Ages, the periods surrounding the collapse of the Hittite empire in central Anatolia. The zooarchaeological analyses that were employed in this research were approached with an eye toward what they can reveal about local responses to the Hittite collapse, whether at the capital (represented by Hattuša) or in the provinces (represented by Çadır Höyük). These analytical categories include taphonomy, species frequencies, survivorship/mortality, biometrics, and skeletal parts analysis. In-depth discussions of the approaches to these categories can be found below. For each category (with the exception of taphonomy), an introduction to the method and the associated interpretive framework is followed by an in-depth discussion of how the analysis was carried out methodologically.

As discussed in the previous chapter, it was recognized that expectations about the form of post-collapse responses (e.g. how local producers would be affected by and respond to the empire's collapse) would be strongly shaped by one's assumptions about the Hittite state and how it functioned as well as by one's assumptions about the process of societal collapse. Consequently, the interpretive frameworks laid out below attempt to take these assumptions into account by presenting two sets of expectations for the impact of the Hittite collapse on local and regional economies. For each aspect of analysis (e.g. species frequency distributions, survivorship), the first set of expectations/interpretations assumes a widespread political and economic integration during the second half of the second millennium, when the Hittites

controlled central Anatolia. The second set of expectations/interpretations assumes rural sites operated largely outside of the Hittite economic system.

As has been discussed elsewhere, the standard narrative of the Hittite collapse is one of a shift from economic centralization to decentralization, from political consolidation to political fragmentation. The expectations laid out below for pre- and post-collapse Hattuša reflect this assumption of a broad shift from “centralized” to “decentralized” organization. In terms of interpretation, however, these expectations should be approached with an eye toward how the results from the zooarchaeological record both align with and depart from such a framework.

#### **4.1 Recording, Recovery, and Taphonomy**

All materials from both sites were recorded using a coding protocol (Appendix) which is a modified version of Meadow’s (1978) “Bonecode.” Fields include, but are not limited to, skeletal element, taxonomy, symmetry, degree of fragmentation, fusion, sex, modifications, and pathology. Biometric data and information on mandibular wear staging were also recorded. A small comparative collection, developed by the author using complete or mostly complete archaeological specimens, was used to assist in identification along with published atlases and digital images.

At Hattuša, the faunal materials to be recorded were selected at the discretion of the project director, focusing only on secure contexts from the relevant periods. Materials from these contexts were primarily hand collected and derive from the 2010, 2011, 2013, and 2014 excavation seasons that center on the southern portion of the Lower Town.

At Çadır, the recorded materials came from a range of contexts, some of which were more secure than others. However, only materials from secure contexts (Priority 1 and Priority 2

contexts in the Çadır site registration system) were included in the results reported here. The majority of these materials was hand collected, though a small proportion was recovered using 5 mm dry sieves. These materials come from numerous excavation seasons: 2001, 2004-2006, 2008-2009, and 2012-2015. At both sites, materials were washed before recording to aid in the identification of butchery marks, heat treatment, etc.

While a full taphonomic analysis (e.g. Bar-Oz et al. 2008) was not conducted on these assemblages, it is important to understand the impact of taphonomic and recovery biases that may impact the interpretation of results as well as comparability between assemblages (Binford 1981; Brain 1981; Lyman 1994; Schiffer 1987; Bar-Oz and Dayan 2002). To this end, several analyses were carried out that allow for an understanding of potential biases resulting from taphonomic and recovery processes. These are described in depth below.

#### *4.1.1 Recovery Index: Analysis of First and Second Phalanges*

In order to assess the efficacy of retrieval methods, relative frequencies of first and second phalanges for cattle (here including specimens identified as *Bos taurus* and as large artiodactyl) and caprines (including specimens identified as *Ovis aries*, *Capra hircus*, *Ovis/Capra*, and medium bovid/cervid) were examined adapting the approaches described by Maltby (1985) and Russell and Martin (2005).

First and second phalanges should appear with equal frequency in archaeological samples given that they occur the same number of times in the body, are both very dense (and thus should not be subject to the same kind of degradation as more porous elements), and are part of the same butchery unit (Russell and Martin 2005: 39). However, smaller bones are not always recovered. Thus examining the relative frequencies of first phalanges (which are larger in size)

vs. second phalanges (which are smaller in size) allows for an understanding of the extent to which small specimens are lost. Examining the frequencies of these elements for animals with larger body sizes (i.e. cattle) against those of animals with smaller body sizes (i.e. caprines) allows for a similar assessment. For the sake of this analysis, frequencies were calculated using simple specimen counts.

#### *4.1.2 Fragmentation Index: Analysis of First and Second Phalanges*

First and second phalanges from cattle (*Bos taurus* and large artiodactyl) and caprines (*Ovis aries*, *Capra hircus*, Ovis/Capra, medium bovid/cervid) were also examined in terms of degree of fragmentation. Because first and second phalanges are small, dense, and contain a very limited amount of marrow, they “are unlikely to be intentionally broken during carcass processing” (Arbuckle 2006: 162). A high degree of fragmentation of these elements would suggest the presence of other kinds of post-depositional activity that could affect the assemblage, e.g. carnivore activity, trampling, weathering, etc.

Fragmentation of these elements was examined by calculating the ratios of diagnostic zone (DZ) counts to simple specimen counts, following Arbuckle 2006. Diagnostic zones are discussed in greater depth in the section on species frequencies below, but in this case they represent articular ends. When DZ counts are divided by specimen counts, “...the resulting index provides a rough measure for fragmentation of these small elements” (Arbuckle 2006: 162). If a first or second phalanx is complete, the specimen count would be one, and the diagnostic zone count would be two since these elements have two articular ends. In this case, the ratio of diagnostic zone count to specimen count would be 2:1, or an index of 2.00. Indices lower than 2.00 indicate fragmentation; the lower the index, the higher the degree of fragmentation.

### *4.1.3 Indices of Taphonomic Loss*

Another approach to examining the effects of taphonomic processes on the Hattuşa and Çadır assemblages was the calculation of indices of taphonomic loss. The first of these calculations was based on the tarsal completeness index described by Marean 1991 and Bar-Oz and Dayan 2002. Following Arbuckle (2006), element completeness was described during recording using a scale of 1 to 5, with “1” representing 0-25% complete; “2” representing 25-50% complete; “3” representing 50-75% complete; “4” representing 75-99% complete; and “5” representing a complete element. Using these categories, an index of completeness was calculated for all medium mammal astragali and second phalanges, combining all periods (Karum period [Middle Bronze I] through Middle Iron). As Arbuckle (2006) writes: “Since these elements are relatively small and do not contain much if any nutritional value, it has been argued that they should not be subjected to regular damage during carcass processing. Damage to these small elements is likely to reflect natural transformation factors...rather than cultural factors such as butchery” (166).

The second approach to calculating an index of taphonomic loss focused on quantifying the potential impacts of density mediated attrition. Based on the approaches of Binford and Bertram (1977) and Brain (1981), and following the framework laid out by Arbuckle (2006), the percentages of the less dense, spongy ends of humeri and tibiae were compared to the total number of specimens of these elements at Hattuşa and Çadır. These calculations included specimens of all species/body sizes. This analysis, which compares the survival of the large, spongy (in this case proximal) ends of these long bones to the survival of their smaller, denser (in this case distal) ends, provides a quantifiable measure of the degree to which less dense skeletal parts may have been differentially impacted by and lost due to taphonomic processes. It also

allows for a comparison of the varying degrees to which different assemblages (i.e. the assemblage at Hattuşa vs. Çadır) may have been affected differently due to these processes.

#### *4.1.4 Modifications*

In the course of data recording a variety of modifications pertaining to taphonomic processes were noted and described. These include carnivore/rodent modification, burning, weathering and butchery. The focus here will be on modifications that relate to carnivore/rodent intervention and heat exposure. For both Hattuşa and Çadır, signs of weathering (based on Behrensmeyer 1978 and Andrews 1990, described by Lyman 1994:355) were extremely limited, suggesting that weathering was not a major factor affecting these assemblages. Butchery modifications will be addressed in depth in a future report.

## **4.2 Species Frequencies**

### *4.2.1 Interpretive Models*

The study of species frequencies, or the relative proportions of different taxa, is one of the most foundational aspects of zooarchaeological analysis. In the zooarchaeology of complex societies, it has been argued that differences in the relative frequencies of different species, as well as demographic information about these animals, can offer insight into the decisions made by herders with regard to production (Redding 1984). Studying these differences can also provide insight into provisioning strategies and can help us understand the degree to which local producers were involved in regional economies (Zeder 1991). For example, it has been argued that an emphasis on raising more versatile but less valued animals such as pigs, can suggest greater decentralization (Zeder 2003). Likewise, a high proportion of sheep to goats can indicate

involvement in a centralized animal economy focused on the commodity production of wool (Arbuckle 2014a). Examining these factors and how they may (or may not) have changed post-collapse can help us understand the broader economic shifts that people may have experienced across the Bronze to Iron Age transition in central Anatolia. That having been said, it is important to keep in mind (as was discussed in depth with the example of pigs in the preceding chapter) that species distributions are entirely context dependent and they should not be interpreted one to one correlations between species abundance and particular forms of economic organization. With this caution in mind, we can lay out some tentative expectations for what species frequencies might look like at Hattuşa and Çadır before and after the Hittite collapse (Table 4.1).

a) **Integration Model:** Assumes widespread political and economic integration during Hittite rule

<i>Site</i>	<i>Hittite Period Expectations</i>	<i>Post-Collapse Expectations</i>
Hattuşa	Lots of cattle (expensive, sign of wealth) Few pigs (pigs associated with decentralization) An abundance of sheep relative to goats (indicator of intensive wool production)	<b>SHIFT:</b> Fewer cattle (too expensive to maintain) More pigs (associated with decentralization) Increase in relative proportion of goats (less emphasis on wool production)
Çadır Höyük	Lots of cattle (expensive, sign of wealth) Few pigs (pigs associated with decentralization) An abundance of sheep relative to goats (indicator of intensive wool production)	<b>SHIFT:</b> Fewer cattle (too expensive to maintain) More pigs (associated with decentralization) Increase in relative proportion of goats (less emphasis on wool production)

b) **Non-Integration Model:** Assumes rural sites largely operated outside of the Hittite economic system

<i>Site</i>	<i>Hittite Period Expectations</i>	<i>Post-Collapse Expectations</i>
Hattuşa	Lots of cattle (expensive, sign of wealth) Few pigs (pigs associated with decentralization) An abundance of sheep relative to goats (indicator of intensive wool production)	<b>SHIFT:</b> Fewer cattle (too expensive to maintain) More pigs (associated with decentralization) Increase in relative proportion of goats (less emphasis on wool production)
Çadır Höyük	Few cattle (too expensive to maintain) Lots of pigs (associated with decentralization) An abundance of goats relative to sheep (indicator of a conservative, low risk production strategy)	<b>NO CHANGE:</b> Fewer cattle (too expensive to maintain) Lots of pigs (associated with decentralization) An abundance of goats relative to sheep (indicator of a conservative, low risk production strategy)

Table 4.1 Expectations for species frequency distributions

During the Hittite period, we might expect the connection between cattle and status to result in the highest frequencies of cattle at the Hittite capital. Cattle tend to be associated with wealth and status in the ancient world (Arbuckle 2014b). Because of their size and the level of care they require, they represent a significant investment in economic resources. However, their symbolic value in many cultures in the ancient world cannot be overlooked. As Arbuckle (2014b) has argued, "...the unique combination of productivity, value, visibility, and symbolism possessed only by cattle made them an essential animal component of Bronze Age Anatolian polities" (278). He also notes the long-standing association between cattle and elites in Bronze Age Anatolia. For Hittites in particular, as an Indo-European "group," Anthony (2007) has emphasized that all Indo-Europeans share a particular obsession with cattle as wealth. In addition, cattle repeatedly appear in Hittite iconography in association with the storm god Teshub, one of the chief gods in the Hittite pantheon (Arbuckle 2014b). For all of these reasons, it is possible that we might see higher proportion of cattle at Hattuša relative to other sites during the Hittite period. As a corollary, we might expect that, with the empire's collapse, and the economic disruption that is believed to have ensued, the proportion of cattle at the site might decrease given the investment of resources they require to maintain. This shift would likely be accompanied by a shift toward animals that are less "valued" but easier to maintain.

One such animal is the pig, which as noted previously, is often associated with "decentralized" economic systems because of its easy maintenance, quick reproduction, and lack of secondary products (which can be exploited for profit by more centralized market systems) (Zeder 1991, 2003). We might expect that, given Hattuša's place at the political and economic heart of the Hittite empire, it might display a low proportion of pigs during the Hittite period. We would also expect that with the collapse of the Hittite empire and the associated breakdown of

regional economies, the proportions of pigs at the site might increase, given the attractiveness of pigs for small-scale household production – they require little space, are quite omnivorous and thus are easy to feed, and they reproduce rapidly.

In terms of caprine production, we would expect that during the Hittite period at Hattuşa there would be a high ratio of sheep to goats. Comparing the relative frequency of sheep to goats can shed light on the emphases of economic production. As noted by Redding (1984), goats are often associated with less centralized animal economies and more conservative herding strategies that emphasize herd security over commodity production. On the other hand, a focus on sheep can be indicative of intensive wool production, particularly when culling strategies target adult animals (both male and female). This kind of herding strategy, focused on the production of wool as a commodity, is often associated with centralized animal economies. Given the role of wool production in regional trade during the Bronze Age in Anatolia (Arbuckle 2012), we would expect that the Hittite capital might be involved in this aspect of production. After the Hittite collapse, we would expect that production at the site might shift towards strategies that emphasize herd security and lowered risk over intensive commodity production. When this happens, the herd structure/demographics change (see the sections on survivorship/mortality and biometrics below), and there is typically an increase in the proportion of goats, which are more versatile, hardier animals (Redding 1984).

At Çadır, the way we envision local responses to the Late Bronze collapse are dependent on how we imagine the relationship between this site and the broader political and economic structure during the Hittite period. If we assume a high degree of political and economic integration between the capital and provinces during the Hittite period (Table 4.1a), we might expect species frequencies at the site to follow our expectations for Hattuşa during Hittite control

of the region, to some degree at least: a relatively high proportion of cattle in relation to periods of less political/economic consolidation, a low proportion of pigs, and a high ratio of sheep to goats. Subsequently, we would expect that, post-collapse, the relative frequencies of cattle might decrease, while those of pigs might increase. We might also expect to see a decrease in the ratio of sheep to goats (i.e. an increase in the frequency of goats).

However, if we assume that rural sites largely operated outside of the Hittite economic system, we will have an entirely different set of expectations (Table 4.1b). In this case, we would expect that Hittite period Çadır might have high proportions of animals such pigs and goats, which tend to be associated with economic decentralization and, in the case of goats, more conservative production strategies. We would also not expect to find an abundance of cattle in this case at Çadır given the amount of resources they require. If rural sites like Çadır were not well integrated into the Hittite economic system, we would expect to see a strong degree of continuity in these signatures post-collapse.

#### *4.2.2 Methods: Quantification by Specimen Count, Weight, and Diagnostic Zone*

To provide a general overview of the assemblages, a summary of the identified specimens from both sites is presented in terms of simple counts. These counts include all specimens, ranging from those identified to genus and species, to those only identified to body size (e.g. small, medium, and large mammal), to those that were unidentified.

For the calculation of species frequencies, unidentified specimens and those where only body size identifications (e.g. small, medium, and large mammal) were possible were excluded. With limited exceptions, noted below, the included mammalian specimens were identified to at least the genus level. Both mammalian and non-mammalian taxa were included. The analytic

categories used in this analysis are “sheep/goat,” cattle (*Bos taurus*), pig (*Sus scrofa*), equid (*Equus sp.*), canid (*Canis sp.*), cervid (*Cervus sp.*), and “other.” The “sheep/goat” category includes specimens identified as sheep (*Ovis aries*), goat (*Capra hircus*), and sheep or goat indeterminate (*Ovis/Capra*). Because of the small number of specimens positively identified as deer (cervids), specimens identified as “medium bovid/cervid” were also included in the “sheep/goat” category. The “other” category includes all other mammals identified to at least the level of the genus that do not fall into the above categories. It also includes rodents (sometimes only identified to the level of the order Rodentia), birds (Aves), amphibians (Amphibia), reptiles (Reptilia), and fish (Pisces).

Species frequencies were examined in three different ways: number of identified specimens (NISP), weight in grams, and diagnostic zone (DZ) counts. NISP involves a simple count of the number of bone fragments identified to each taxon or size category and assumes that each bone fragment is independent (i.e., belongs to a separate individual and is not part of a bone that is already represented in the assemblage) (Lyman 2008). One of the disadvantages of using NISP, however, is that a simple fragment count can lead to the systematic underrepresentation of animal species that have fewer elements than others (Davis 1987; Reitz and Wing 2008). For example, equids, which have only a single digit on each limb, may yield a lower fragment count than suids, which have four digits on each limb, even if the numbers of individuals present is the same.

Quantification by weight, on the other hand, disregards fragmentation and emphasizes animal size (Uerpmann 1973). It takes multiple sheep or pigs, for example, to equal a cow in regards to meat weight. Calculating species frequencies by bone weight offers a rough

approximation of this difference, which may not be visible in species distributions based on NISP (Uerpmann 1973).

Finally, analysis using diagnostic zones (adapted from Watson 1979) focuses on counting specific portions of skeletal elements that have a high survival rate in the archaeological record and employs a counting system that helps balance out skeletal differences across species. This helps account for the impacts of certain taphonomic processes and variations in anatomy between different taxa, such as the differences in the number of elements across species that can skew NISP counts, mentioned above.

In addition, the ratio of sheep (*Ovis aries*) to goats (*Capra hircus*) was calculated for all samples from Hattuşa and Çadır where sample size was adequate. This ratio was calculated by dividing the number of specimens identified as sheep by the sum of specimens identified as sheep plus specimens identified as goats.

## **4.3 Survivorship and Mortality**

### *4.3.1 Interpretive Models*

Demographic information about different species can offer insight into the decisions made by herders with regard to production (Redding 1984). For example, age at death will be affected by the products producers are focused on obtaining (e.g. meat vs. wool vs. dairy vs. a combination of these products). Different production emphases can result in distinctive patterns of survivorship and mortality which can be identified archaeologically (e.g. Payne 1973). This is because different emphases of production result in male and female animals being killed off at different ages. Moreover, previous work has suggested that we can relate animal demographics not just to the specific products being generated but to broader systems of production and

provisioning. For example, if rural producers are supplying market-aged animals as meat to urban consumers, rural sites might end up with few market aged animals and urban sites with many of them. This pattern is described by Stein (1987) in relation to work at the village site of Gritille in southeast Turkey, which was sending prime meat weight animals to nearby centers.

These broader structures of production are often presented in terms of centralized or decentralized economic organization, with centralized organization being “characterized by the control of production, consumption, and redistribution of resources by a limited and privileged group of people” (Atici 2005: 120). Animal husbandry practices which focus on intensive production in order to produce surplus (e.g. intensive wool production) tend to be associated with more centralized economic regimes (Arbuckle 2012), while decentralized animal economies are characterized in terms of diversification, emphasizing herd security over surplus production. These distinctions are often mapped on to supposed divides between urban and rural lifeways.

It is important to keep in mind that zooarchaeological models for the survivorship and mortality patterns created by particular production and provisioning practices are only ideal types and rarely appear in these exact forms archaeologically. For example, the classic caprine survivorship profiles for production focused on meat vs. dairy vs. wool vs. herd security seems to imply that the emphasis of production is on a single goal, when in reality, in almost all cases a combination of primary and secondary products is being exploited, but in differing proportions (Payne 1973). However, these ideal types still serve as useful tools for considering the significance of patterns uncovered in the archaeological record.

Using these models, we can suggest some interpretive frameworks for the kinds of survivorship/mortality patterns we might find at Hattuşa and Çadır Höyük before and after the Hittite collapse. We will first consider caprine production strategies (Table 4.2) before turning to

caprine provisioning (Table 4.3). Data on survivorship and mortality can inform us about provisioning as well as production. It is important to consider both of these aspects of animal use given that the same survivorship/mortality patterns can have conflicting meanings when examined in light of the patterns yielded by particular production vs. provisioning strategies. Finally, we will briefly discuss potential interpretive frameworks for cattle survivorship and mortality patterns at Hattuša and Çadır.

Given the importance of wool production in Bronze Age states in the Ancient Near East (Algaze 2008; Arbuckle 2012) and in the Hittite world in particular (see Chapter 2), it seems likely that intensive wool production (with a focus on producing surplus) would be an important aspect of the Hittite period animal economy of Hattuša. For this reason, during the Hittite period, we might expect to see demographic patterns reflecting this kind of production strategy (Table 4.2). According to the zooarchaeological literature (Payne 1973, Helmer et al. 2007, Stein 1987, Arbuckle 2012), an emphasis on wool/fiber production often results in a high level of survivorship older animals (particular females and wethers, which produce the highest quality of wool). When the goal is wool production, adult animals are killed off as wool quality declines (Payne 1973: 281). Thus, during the Hittite period, we might to see an abundance of caprines kept into adulthood to be exploited for wool/fiber. After the Hittite collapse, we might expect a shift away from this emphasis on commodity production due to the collapse of regional markets and a growing need to address local needs for other products (both primary and secondary). Zooarchaeologically this shift away from centralized commodity production could be manifested as a more decentralized, diversified caprine production strategy signified by the gradual kill-off of animals across multiple age groups.

a) **Integration Model:** Assumes widespread political and economic integration during Hittite rule

<i>Site</i>	<i>Hittite Period Expectations</i>	<i>Post-Collapse Expectations</i>
Hattuşa	Evidence for surplus commodity production focused on secondary products; if fiber, most caprines (especially castrated males) not culled until later in life	<b>SHIFT</b> to generalized, low-risk caprine management, focused on herd security: gradual kill-off of animals over time (there should not be a concentrated peak in kill-off)
Çadır Höyük	Evidence for surplus commodity production focused on secondary products; if fiber, most caprines (especially castrated males and females) not culled until later in life	<b>SHIFT</b> to more generalized, low-risk, herd stability model of caprine management: more gradual kill-off of animals over time (there should not be a concentrated peak in kill-off)

b) **Non-Integration Model:** Assumes rural sites largely operated outside of the Hittite economic system

<i>Site</i>	<i>Hittite Period Expectations</i>	<i>Post-Collapse Expectations</i>
Hattuşa	Evidence for surplus commodity production focused on secondary products; if fiber, most caprines (especially castrated males and females) not culled until later in life	<b>SHIFT</b> to generalized, low-risk caprine management, focused on herd security: gradual kill-off of animals over time (there should not be a concentrated peak in kill-off)
Çadır Höyük	Depending on local organization during Hittite Period: 1) Evidence for surplus commodity production focused on secondary products: if fiber, most caprines (especially castrated males and females) not culled until later in life <u>OR</u> 2) Evidence for generalized, low-risk caprine management, focused on herd security: gradual kill-off of animals over time (there should not be a concentrated peak in kill-off)	If 1) <b>NO CHANGE:</b> Evidence for continued surplus commodity production (lots of older animals if focus is on fiber) <u>OR</u> If 2) <b>NO CHANGE:</b> Evidence for continued generalized caprine management: gradual kill-off of animals over time

Table 4.2 Expectations for caprine survivorship/mortality (production)

At Çadır, caprine survivorship/mortality outcomes vary depending on how we imagine the place of the site within the central Anatolian political structure in latter half of the Bronze Age. If we assume a high degree of integration between the capital and the surrounding rural sites during the Hittite period, it seems possible that Çadır would show signs of a focus on rural/fiber production (i.e. an abundance of older animals) as part of the Hittite wool economy. After the empire's collapse, we would expect a shift toward a more generalized, less intensive caprine production strategy at Çadır as the inhabitants of the site responded to the loss of regional economic stability once provided by the Hittite empire. On the other hand, if we envision that rural sites like Çadır operated largely outside of the Hittite economic system, we

would expect that, regardless of the structure of the Bronze Age animal economy at Çadır, the transition to the Iron Age would be marked by continuity in caprine production strategies. Thus, whether herders at Çadır were focused on the intensive surplus production of commodities (such as wool), or on a more diversified production strategy with the aim of herd security, this pattern should be unaffected by the empire's collapse.

When examined in terms of provisioning (Table 4.3) these patterns can take on different meanings. Assuming political and economic integration between capital and provinces during the Hittite period, it is possible that rural sites would be supplying the capital with animals for meat (Zeder 1991; Stein 1987), either as tribute or as part of the regional market. If, for example, Çadır were supplying Hattuşa (or other large Hittite sites nearby) with prime meat weight animals during the Hittite period (Table 4.3a), this provisioning activity would result in a pattern where caprines in this age range (2-3 years [Stein 1987]) were largely absent at Çadır but present in large proportions at Hattuşa (or elsewhere).

a) **Integration Model-Alternative I:** Assumes widespread political and economic integration during Hittite rule

<i>Site</i>	<i>Hittite Period Expectations</i>	<i>Post-Collapse Expectations</i>
Hattuşa	Evidence for receiving animal provisions for meat: excess of young and/or prime meat weight animals (aged 2-3 years) ["desirable" animals sent to capital]	<b>SHIFT</b> to producing own animals with collapse of regional market: animals present in all age ranges
Çadır Höyük	Evidence for providing animals for provisioning: absence of "market-aged" animals (mainly juvenile and older animals present)	<b>SHIFT</b> to retaining more animals with collapse of regional market: animals present in all age ranges

b) **Integration Model-Alternative II:** Assumes widespread political and economic integration during Hittite rule

<i>Site</i>	<i>Hittite Period Expectations</i>	<i>Post-Collapse Expectations</i>
Hattuşa	Evidence for receiving animal provisions for meat: absence of young and/or prime meat weight animals; mostly older animals present ["worn out" animals sent to capital]	<b>SHIFT</b> to producing own animals with collapse of regional market: animals present in all age ranges
Çadır Höyük	Evidence for providing animals for provisioning: absence of older animals (mostly juvenile and prime meat weight animals present) ["worn out" animals sent to capital"]	<b>SHIFT</b> to retaining more animals with collapse of regional market: animals present in all age ranges

c) **Non-Integration Model:** Assumes rural sites largely operated outside of the Hittite economic system

<i>Site</i>	<i>Hittite Period Expectations</i>	<i>Post-Collapse Expectations</i>
Hattuşa	No evidence for being part of a regional provisioning system: animals present in all age ranges	<b>NO CHANGE:</b> animals present in all age ranges
Çadır Höyük	No evidence for being part of a regional provisioning system: animals present in all age ranges	<b>NO CHANGE:</b> animals present in all age ranges

Table 4.3 Expectations for caprine survivorship/mortality (provisioning)

Another variation of this kind of provisioning activity would appear if, as Arbuckle (2012) has argued was the case at Bronze Age Achemhöyük in central Anatolia, rural producers were keeping prime meat weight animals for themselves and were sending older, "worn out" animals (beyond the age of peak dairy or wool production) to market (Table 4.3b). If this were the case, we might see an over-abundance of older animals at centers like Hattuşa. (Interestingly, this can mimic the expected pattern for wool production discussed above.) At the same time, this same age range of animals would be largely absent at Çadır.

If this kind of provisioning system, where rural sites were providing larger sites with animal resources, was present during the Hittite period, we would expect that the empire's collapse might cause the system to be disrupted. No longer able to rely on a supply of caprines from outside the settlement, the inhabitants of Hattuša would begin raising more animals locally. If this were the case, we would expect a wider array of caprine age ranges to be represented during the Iron Age at the site. Likewise, at rural sites like Çadır, if there was no longer a demand for sending animals to regional markets, we would similarly expect a shift toward individual animals from all age ranges present at the site.

Alternatively, if we assume that animal economies at the Hittite capital and rural sites like Çadır were not intertwined and operated largely independently, during the Bronze we would not expect to see as much evidence for the provisioning of animal resources between sites (Table 4.3c). If animal economies at these settlements were more "self-contained," and they were providing themselves with animal resources, we would instead expect to see a full range of caprine age groups represented in the sites' survivorship/mortality profiles (as opposed to a concentration of, for example, market-aged animals). Moving into the Iron Age, we would expect to see this pattern continue after the Hittite empire's collapse, given the assumption that the removal of the Hittite political system would not have a considerable impact on the regional economy in this aspect.

Potential expectations for cattle survivorship at both sites before and after the Hittite collapse are a bit more straightforward than what we might expect to see for caprines. Generally speaking, for most historic periods in agro-pastoral societies in the ancient Near East, the expectation is that cattle will tend to be used for traction, meaning that these animals are typically kept well into adulthood and are not killed off earlier in large numbers because they

represent a significant investment of resources (Arbuckle 2014b). This is something we might expect to see at both an urban site like Hattuşa and a rural center like Çadır. However, given the long-standing association between cattle and elites in Bronze Age Anatolia (Arbuckle 2014b) and the wealth of Hittite capital, we might expect to see a higher consumption of younger cattle at Hattuşa during the Hittite period compared to rural Çadır and a shift away from this kind of consumption after the Hittite collapse.

At Çadır, on the other hand, assuming integration with the broader Hittite economy, we might expect cattle frequencies at the site to echo those anticipated for Hattuşa during the Hittite period and after the Hittite collapse. Alternatively, it might be the case that, both during the Hittite period and later during the Iron Age, the need to keep cattle in use for as long as possible for traction likely would have outweighed the benefit of consuming younger cattle.

#### *4.3.2 Methods: Quantification by Mandibular Wear and Epiphyseal Fusion*

Age data for caprines and cattle were analyzed using mandibular wear and epiphyseal fusion. Aging through mandibular wear allows for an estimate of age at death through the examination of wear patterns in an animal's teeth. These patterns change over the course of the animal's life as the animal ages and its tooth enamel wears down over time. Epiphyseal fusion, on the other hand offers a more general estimate of age by assessing whether an individual died before or after the age at which a given skeletal element is known to fuse. For example, in cattle, the distal tibia is known to fuse between two and two and a half years (Silver 1963). Thus, an unfused distal tibia would indicate that the individual is younger than two to two and a half years, and a fused distal tibia would indicate that the animal lived beyond this age. This approach to aging is limited by the fact that lifespans of the major domesticates (e.g. cattle, caprines) can

extend far beyond the age at which the last long bones fuse (three to four years). For this reason, aging using epiphyseal fusion evidence is limited in resolution, particularly for the later life stages.

Mandibular wear stages were assigned for sheep and goats following Payne (1973). For both Hattuşa and Çadır Höyük, the number of mandibles that could be identified to the species level (i.e. *Ovis aries* or *Capra hircus*) was low, so for both sites, the analysis includes the combined mandibular wear stages for all caprines (i.e. those of specimens identified as *Ovis*, *Capra*, and *Ovis/Capra*). Calculations were made by including mandibles with teeth, loose mandibular deciduous fourth premolars, and loose mandibular third molars. For specimens that had been assigned multiple wear stages (e.g. Payne's CD or DEF), values were distributed evenly between wear stages (e.g. CD was broken down into C=.5 and D=.5; DEF was broken down into D=.333, E=.333, and F=.333). Specimens assigned more than three wear stages were excluded from the analysis.

Epiphyseal fusion stages for caprines were assigned following Zeder's (2006) reassessment of caprine aging measures. The analysis included specimens identified as *Ovis*, *Capra*, and *Ovis/Capra*. Given the low numbers of cervids (particularly smaller cervids) in both the Hattuşa and Çadır assemblages, specimens identified as medium bovid/cervid were also included in these calculations. To aid in interpretation of the results, Zeder's (2006) age categories were condensed into three stages: Stage I, juvenile (0-12 months); Stage II, young adult (12-30 months); and Stage III, adult (30+ months). Caprine epiphyseal fusion results are presented in terms of these three categories.

Mandibular wear stages for cattle were assigned following Grant (1975). However, because the samples of cattle mandibles/mandibular teeth were small in all cases, cattle

mandibular wear stages were excluded from the analysis below. Cattle epiphyseal fusion stages were assessed following the fusion rates described by Silver (1963). These age categories were also condensed into three age stages to aid in analysis: Stage I, juvenile (6-18 months); Stage II, young adult (24-36 months); and Stage III, adult (42+ months).

## **4.4 Biometrics**

### *4.4.1 Interpretive Models*

Body dimensions in animals are affected by a number of factors including but not limited to age, sex, domestication, and nutrition (Weinstock 2000; Zeder 2001; Reitz and Wing 2008: 183-184). Changes in body dimension can signify physiological responses to factors such as climate change (Reitz and Wing 2008: 183), and they can be indicative of the introduction of new animal breeds/populations to a given region. Because studying animals' body dimensions can provide information about wide range of areas, zooarchaeologists have found them to be a valuable area of study. At the same time, however, because so many factors can have an effect on body dimensions, these results of these studies can be difficult to interpret.

For the purposes of this study on the collapse of the Hittite empire and its aftermath, the decision was made to focus primarily on examining differences in body dimensions that could inform about changes and/or continuities in production and provisioning/distribution strategies. This approach draws on work (discussed above in the context of survivorship/mortality) arguing that producers' decisions about when to kill off male and female animals are shaped by their production goals (i.e. whether the focus is on producing primary or secondary products) (Redding 1984; Payne 1973). It also draws on work arguing that patterns of provisioning for animals of different ages/sexes can be affected by producers' participation in regional

distribution systems, for example, where male sheep that have reached prime meat weight are sent to market (Stein 1987; Zeder 1991). Based on differences in the size ranges of juvenile, adult female, and adult male animals (as well as castrates), evidence for these production and provisioning strategies can sometimes be identified archaeologically by studying variation in the body size distributions of archaeological animal populations, which can be tentatively mapped onto differences in sex (Reitz and Wing 2008).

As with the interpretive frameworks of survivorship/mortality described above, the biometric evidence will first be discussed in terms of how it can speak to the interpretation of production strategies (Table 4.4). Second, it will be discussed in terms of provisioning strategies (Table 4.5). Clearly this approach necessitates an artificial division between overlapping categories in the use of animals and their products, but it helps highlight how similar evidence can yield different results depending on the interpretive approach. In all cases, the best approach is to combine the results on mortality and survivorship with the biometrics (which can inform about sex distributions) in order to gain a better understanding of herd demographics, facilitating better interpretations.

During the Hittite period at Hattuša we might expect that, if as has been discussed previously in the section on survivorship, there was an emphasis on the production of secondary products, particularly, fiber, that most male sheep (particularly castrated males) would not be culled until later in life in order to maximize wool production (Table 4.4). Female sheep would also be kept alive until no longer fertile and/or no longer producing quality wool. However, unlike other in other production strategies (i.e. for meat, dairy), the commodity production of wool results in more male sheep being kept alive for longer (Payne 1973). Thus, in terms of biometric results, we would expect to see a higher than usual proportion of larger-bodied animals

representing male sheep. After the Hittite collapse, we would expect to see a shift toward a more low-risk sheep management strategy that prioritizes herd security over commodity production. This kind of strategy would result in a different distribution of body sizes, with a lower proportion of large males relative to smaller females and younger animals (Redding 1984).

In terms of cattle at Hattuša, it has previously been argued that cattle at the site during the Hittite period were large and well-developed/robust (von den Driesch and Pöllath 2003). We thus might expect to see similar results in the Hittite period samples included in this analysis. After the Hittite collapse we might expect to see a decrease in cattle size at the site, paralleling the decrease in cattle size after the Roman retreat from Great Britain (Rizzetto et al. 2014). This could result from poor nutrition/fewer resources to care for the animals or potentially the introduction of new cattle populations along with the movement of people in the region during the Early Iron Age.

Expectations for patterns at Çadır once again depend on whether or not we assume we assume widespread political and economic integration during Hittite rule. If Çadır was well-integrated into a regional economy (Table 4.4a) with an emphasis on the production of wool as a commodity during the Hittite period as we discussed regarding Hattuša, we would likely expect to see a similar sheep biometric signature at Çadır, with an abundance of large-bodied (likely adult male) sheep at the site. Post collapse, we would expect to see a similar shift away from intensive commodity production, resulting in a lower proportion of large males compared to the Hittite period. We might expect to likewise see parallels in cattle biometric signatures both before and after the Hittite collapse, with large-bodied cattle during the Hittite period, and a decrease in cattle size post-collapse.

a) **Integration Model:** Assumes widespread political and economic integration during Hittite rule

<i>Site</i>	<i>Hittite Period Expectations</i>	<i>Post-Collapse Expectations</i>
Hattuşa	<p><u>Sheep:</u> Evidence for surplus commodity production focused on secondary products; if fiber, most sheep, especially castrated males, not culled until later in life; therefore a high proportion of sheep with large body size (likely representing males)</p> <p><u>Cattle:</u> Evidence for cattle (both male and female) with large size range, due to cattle being “improved” and well-fed</p>	<p><b>SHIFT</b> to generalized, low-risk sheep management, focused on herd security: gradual kill-off of animals over time, resulting in a wider range of body sizes (representing larger males and smaller females/younger animals); lower proportion of large males than before</p> <p><b>SHIFT</b> to cattle with smaller body size overall, either due to changes in nutrition or introduction of new cattle varieties along with population movements</p>
Çadır Höyük	<p><u>Sheep:</u> Evidence for surplus commodity production focused on secondary products; if fiber, most caprines, especially castrated males and females, not culled until later in life therefore an abundance of sheep with large body size (likely representing males)</p> <p><u>Cattle:</u> Evidence for cattle (both male and female) with large size range, due to cattle being “improved” and well-fed</p>	<p><b>SHIFT</b> generalized, low-risk sheep management, focused on herd security: gradual kill-off of animals over time, resulting in a wider range of body sizes (representing larger males and smaller females/younger animals); lower proportion of large males than before</p> <p><b>SHIFT</b> to cattle with smaller body size overall, either due to changes in nutrition or introduction of new cattle varieties along with population movements</p>

b) **Non-Integration Model:** Assumes rural sites largely operated outside of the Hittite economic system

<i>Site</i>	<i>Hittite Period Expectations</i>	<i>Post-Collapse Expectations</i>
Hattuşa	<p><u>Sheep:</u> Evidence for surplus commodity production focused on secondary products; if fiber, most sheep, especially castrated males, not culled until later in life; therefore a high proportion of sheep with large body size (likely representing males)</p> <p><u>Cattle:</u> Evidence for cattle (both male and female) with large size range, due to cattle being “improved” and well-fed</p>	<p><b>SHIFT</b> to generalized, low-risk sheep management, focused on herd security: gradual kill-off of animals over time, resulting in a wider range of body sizes (representing larger males and smaller females/younger animals); lower proportion of large males than before</p> <p><b>SHIFT</b> to cattle with smaller body size overall, either due to changes in nutrition or introduction of new cattle varieties along with population movements</p>
Çadır Höyük	<p><u>Sheep:</u> Depending on local organization during Hittite Period: 1) Evidence for surplus commodity production focused on secondary products; if fiber, most sheep, especially castrated males, not culled until later in life; therefore a high proportion of sheep with large body size (likely representing males) <u>OR</u> 2) Evidence for generalized, low-risk caprine management, focused on herd security: gradual kill-off of animals over time, resulting in a range of body sizes (representing larger males and smaller females/younger animals)</p> <p><u>Cattle:</u> Cattle could be large like those at Hattuşa or there could be possible evidence for cattle (both male and female) with smaller size range than what is seen at Hattuşa if there is a different variety at Çadır or fewer resources to care for them</p>	<p>If 1) <b>NO CHANGE:</b> Evidence for continued surplus commodity production; high proportion of sheep with large body size <u>OR</u> If 2) <b>NO CHANGE:</b> Evidence for continued generalized caprine management: gradual kill-off of animals over time, resulting in a range of body sizes</p> <p><b>NO CHANGE</b> in cattle body size from the preceding period</p>

Table 4.4 Expectations for biometric evidence (production)

On the other hand, if we envision that rural sites like Çadır operated largely outside of the Hittite economic system (Table 4.4b), we would expect that, regardless of the structure of the Bronze Age animal economy at Çadır, the transition to the Iron Age would be marked by continuity. Thus, in terms of sheep production, whether herders at Çadır were focused on the intensive surplus production of commodities (such as wool) (resulting in an unusually high proportion of large-bodied adult males) or on a more diversified production strategy with the aim of herd security (resulting biometrically in a lower proportion of adult males), this pattern should be unaffected by the empire's collapse. Likewise, the cattle size range at Çadır should show continuity pre- and post-collapse.

In terms of evidence relating to provisioning, we would expect that, as discussed elsewhere, a large site like Hattuşa would have a specialized provisioning system in place during the Hittite period (Zeder 1991). This might result in a system where producers from smaller rural sites around the region like Çadır supplied the settlement with animals for meat. One version of this involves rural producers sending “market-aged” animals which have reached prime meat weight to urban consumers (Stein 1987). If Hattuşa was being supplied with animals once they reached prime meat weight, this could result in an abundance of larger-bodied animals (likely males) and a lack of smaller-bodied animals (likely females) (Table 4.5a). At the same time, these “market-aged” animals might be missing from the Çadır assemblage, resulting in a situation where more smaller-bodied (likely female animals and younger animals) are present.

On the other hand, power dynamics are not always such that urban consumers receive the most desirable meat. It is sometimes the case that rural producers send older, “worn out” animals to urban consumers (Arbuckle 2012). If rural sites were supplying Hattuşa with older animals (e.g. such as older male sheep that had been used for wool production), we might expect to see

both male and female animals (older males and females once used for wool and older females once used for dairy/breeding) (Table 4.5b).

a) **Integration Model-Alternative I:** Assumes widespread political and economic integration during Hittite rule

<i>Site</i>	<i>Hittite Period Expectations</i>	<i>Post-Collapse Expectations</i>
Hattuşa	<b>Sheep and Cattle:</b> Evidence for receiving animal provisions for meat: an abundance of prime meat weight animals results in an abundance of larger-bodied animals (likely males) and a lack of smaller-bodied animals (likely females) [prime meat weight animals sent to capital]	<b>SHIFT</b> to producing own animals with collapse of regional market: both larger (likely male) and smaller (likely female) sheep and cattle present in similar proportions
Çadır Höyük	<b>Sheep and Cattle:</b> Evidence for providing animals for provisioning: absence of “market-aged”; more smaller-bodied (likely female and younger) animals present than larger-bodied animals [prime meat weight animals sent to capital]	<b>SHIFT</b> to retaining more animals with collapse of regional market: both larger (likely male) and smaller (likely female) sheep and cattle present in similar proportions

b) **Integration Model-Alternative II:** Assumes widespread political and economic integration during Hittite rule

<i>Site</i>	<i>Hittite Period Expectations</i>	<i>Post-Collapse Expectations</i>
Hattuşa	<b>Sheep and Cattle</b> Evidence for receiving animal provisions for meat: absence of young and/or prime meat weight animals; mostly older animals present; both larger (likely male) and smaller (likely female) sheep and cattle present [“worn out” animals sent to capital]	<b>SHIFT</b> to producing own animals with collapse of regional market: both larger (likely male) and smaller (likely female and younger) sheep and cattle present; signature may not change noticeably
Çadır Höyük	Evidence for providing animals for provisioning: absence of older animals (mostly juvenile and prime meat weight animals, both male and female, present ) [“worn out” animals sent to capital”]	<b>SHIFT</b> to retaining more animals with collapse of regional market: both larger (likely male) and smaller (likely female) sheep and cattle present; signature may not change noticeably

c) **Non-Integration Model:** Assumes rural sites largely operated outside of the Hittite economic system

<i>Site</i>	<i>Hittite Period Expectations</i>	<i>Post-Collapse Expectations</i>
Hattuşa	No evidence for being part of a regional provisioning system: both larger (likely male) and smaller (likely female) sheep and cattle present	<b>NO CHANGE:</b> both larger (likely male) and smaller (likely female) sheep and cattle present
Çadır Höyük	No evidence for being part of a regional provisioning system: both larger (likely male) and smaller (likely female) sheep and cattle present	<b>NO CHANGE:</b> both larger (likely male) and smaller (likely female) sheep and cattle present

Table 4.5 Expectations for biometric evidence (provisioning)

If we assume that rural sites were operating largely outside of the Hittite economic system, in terms of provisioning, we would expect that Çadır might be less engaged with regional markets during the Hittite period (Table 4.5c). For this reason, we would expect the

biometric results from Çadır to show a range of body sizes, with both larger-bodied (likely male) and smaller-bodied (likely female and younger) animals present, given that animals of particular sex/age groups would be kept at the site rather than being sent to market. Post-collapse, we would expect this pattern to remain the same. Similarly, if Hattuşa was not as involved in regional markets (Table 4.5c) we would expect that evidence for provisioning there, as evidenced by biometric patterns, would be similar.

Goat husbandry patterns in the ancient Near East tend to be fairly stable across time and across contexts; unless intensive hair production is a goal, herd structure tends to include mostly females and a few large males that are kept for breeding (Zeder 2008) For this reason, in terms of the biometric evidence at both sites, pre- and post-collapse, we would expect that most of the animals would be smaller-bodied (representing females) with a few larger bodied animals (representing males).

#### *4.4.2 Methods: Quantification Using a Logarithmic Size Index*

In order to make estimates of body dimensions, standard measurements were used. During data recording, standard measurements of animal bones were taken following the measurement standards set out by von den Driesch (1976) whenever skeletal elements were complete enough to allow for measurement. Every possible measurement was not taken; only those measurements that zooarchaeologists have traditionally considered to be diagnostic were recorded. Taken together, the recorded measurements provide a quantifiable index of the allometry (shape) of the measureable skeletal elements.

During the quantification process, these measurements were analyzed in order to examine changes in animal size/shape over time and across the two sites. This analysis was carried out for

three of the main taxa: sheep, goats, and cattle. In order to facilitate comparison, a log size index (LSI) was used. LSI helps to ameliorate the effect of small sample size by placing each measurement in relationship to the same measurement on a “standard” animal. For example, all of the sheep first phalanx greatest lengths in the archeological population are placed in reference to the first phalanx greatest length of a standard sheep. The formula for this is  $\log(\text{find measurement}) - \log(\text{standard animal}) = \text{log size index (LSI)}$  (Uerpmann and Uerpmann 1994: 429). This formula was followed for each skeletal element for each of the three taxa, transforming each measurement that had an equivalent recorded for the standard animal. This process creates an index for each of the measurements that allows comparison across different measurements for different elements and enables comparability across collections, all while increasing sample size. The transformed measurements can cautiously be treated as regular data; though the log transformation can have some effect, it is generally small (Uerpmann and Uerpmann 1994: 429).

For skeletal elements that are mostly complete, standard zooarchaeological practice entails taking multiple length and breadth measurements. However, to avoid inadvertently double counting specimens, a single measurement (e.g. greatest breadth, proximal breadth) was chosen to represent each element/species within each sample. For example, for the sample of Hittite period sheep at Çadır, the trochlear breadth (BT) measurement was taken to represent humeri. Generally speaking, the most abundant measurement for each element for each site/time period for each taxon was the one chosen. All other things being equal, breadth measurements were prioritized over length measurements because breadth measurements tend to better reflect changes in artiodactyl robusticity (Meadow 1999; Albarella 2002: 55). In addition, unfused

specimens were eliminated from the analysis in order to help reduce blurring between sex and age.

The sheep and goat standards used were those published by Uerpmann and Uerpmann (1994). The sheep standard measurements were taken from a modern female *Ovis orientalis* (FMC 57951), a wild sheep sub-species known as the mouflon. The goat standard measurements were taken by averaging the measurements from a male and female *Capra aegagrus* (BHM 651 M and L2), a wild goat species; both individuals came from the Taurus Mountains. The cattle standard used represents a nineteenth century Pinzgau cow skeleton (SAPM-MA-01254). This skeleton is housed at the Institut für Palaeoanatomie, Domestikationsforschung und Geschichte der Tiermedizin, Ludwig-Maximilians Universität München and represents a “primitive” variety.

The LSI values for each sample were plotted as histograms. In each histogram, the standard animal appears as “zero.” LSI values above zero are larger than the standard animal, while those smaller than zero are smaller than the standard animal.

Given the low incidence of caprines and cattle identified as wild at both Hattuşa and Çadır, and the generally low numbers of non-domesticated sheep, goats, and cattle at other central Anatolian sites during the Middle Bronze through Iron Ages, it was assumed that the majority of the measurements included in the analysis came from domesticated animals. In the case of sheep, because the standard measurements represent a wild female it was expected that the domesticated populations at Hattuşa and Çadır might skew smaller than the standard, which appears as “0” in the LSI histograms below. In the case of cattle, on the other hand, because the standard measurements represent a domesticated cow, it was expected that the archaeological measurements (likely deriving mostly from domesticated cattle) would be more similar to those of the standard animal.

For some samples, sample sizes were too small to conduct LSI analysis of the measurements. These exclusions are noted in the relevant sections below. For this reason, Hittite period Kesikkaya South was excluded entirely from LSI analysis. The same holds true for the Hittite period material from Kesikkaya Northwest.

## **4.5 Skeletal Parts**

### *4.5.1 Interpretive Models*

Zooarchaeologists have long argued for the presence of specialized provisioning systems in complex societies, especially urban ones (e.g. Crabtree 1990; Zeder 1991; Arbuckle 2012). Animal remains, Crabtree (1990:158) suggests, “[provide] one way that we can use archaeological data to study this provisioning process.” She continues, “The redistribution and/or marketing of meat and other animal products should produce some degree of patterning of faunal assemblages at both producer and consumer sites” (Crabtree 1990: 158). Studying the representations of different skeletal parts across sites or within different areas of the same site is one way of studying those patterns, offering insight into butchery practices and provisioning systems at these sites (Zeder 1991; Arbuckle 2012).

Frequently, skeletal parts are classified by zooarchaeologists as either “butchery waste” or “consumption waste” (Crabtree 1990; Uerpman 1973; Zeder 1991) (Table 4.6). The presence of both butchery waste (e.g. elements of the skull, elements of the feet) and consumption waste (e.g. elements of the forelimb and hindlimb, which represent high quality cuts of meat) in the same location suggests that animals were butchered and consumed in the same area. This pattern may indicate that local consumers acquired animals directly from producers and brought in the animals on the hoof, with butchery and consumption occurring in the same area. Alternatively, it

may suggest that consumers were raising (and butchering) the animals themselves. In contrast, the absence of either butchery waste or consumption waste, or the spatial separation of these categories, can be indicative of a specialized provisioning system, where butchery and consumption activities take place in different locations (Arbuckle 2012: 468). In this case, cuts of meat (generally represented in the zooarchaeological record by the bones of the forelimb, the hindlimb, and the pelvis) would be acquired from a central location (e.g. a butcher). These cuts of meat would be cooked and consumed elsewhere, and butchery waste would remain in the area where butchering activity occurred.

Butchery Waste	Head (e.g. petrosal, mandible, maxilla, teeth)
	Extremity (e.g. carpals, tarsals, metapodials, phalanges)
Consumption Waste	Forelimb (e.g. scapula, humerus, radius, ulna)
	Hindlimb (e.g. femur, tibia, fibula, patella)

Table 4.6 Typical examples of butchery and consumption waste

Drawing from these models regarding butchery and provisioning, we can suggest some interpretive frameworks for the kinds of patterns we might find at Hattuša and Çadır Höyük before and after the Hittite collapse (Table 4.7). Given its settlement size, we would expect to see evidence for a complex, specialized provisioning system at Hattuša for much its history as a large urban center. The presence of such a system seems especially likely during the Hittite period when the Hattuša served as the Hittite capital. The Hittite royal court, the city's many temples, and the craft specialists who supported them would have needed a supply of animal resources to sustain themselves. The expectation for a specialized provisioning system of animal resources is supported by archaeological evidence for the centralized administration of other forms of resources at Hattuša at this time, such as the large scale grain storage at Büyükkaya (Seeher 2002). Evidence for the provisioning of animal products at the site might be manifested

as a spatial separation between consumption waste and butchery waste, with heads and feet appearing in some areas of the site (where butchery might have been taking place) and meaty limb bones (representing consumption) appearing in others. Alternatively, if butchery were occurring offsite, we would expect an abundance of meat-rich parts on site and a dearth of butchery waste.

At Çadır Höyük, we might also expect to see some evidence for provisioning during this time given the site's status as a local center. However, its position in the rural economy of central Anatolia increases the chances that its inhabitants were either raising animals for their own use or interfacing directly with producers to obtain animals for meat as opposed to obtaining cuts of meat through a provisioning system.

a) **Integration Model:** Assumes widespread political and economic integration during Hittite rule

<i>Site</i>	<i>Hittite Period Expectations</i>	<i>Post-Collapse Expectations</i>
Hattuşa	Evidence for specialized provisioning: spatial separation of butchery and consumption waste	<b>SHIFT</b> to non-specialized provisioning: butchery and consumption waste appear together
Çadır Höyük	Depending on local organization during Hittite Period: 1) Evidence for specialized provisioning: separation of butchery and consumption waste <u>OR</u> 2) Non-specialized provisioning -- butchery and consumption waste appear together	If 1) <b>SHIFT</b> to non-specialized provisioning: butchery and consumption waste appear together <u>OR</u> If 2) <b>NO CHANGE</b> butchery and consumption waste appear together

b) **Non-Integration Model:** Assumes rural sites largely operated outside of the Hittite economic system

<i>Site</i>	<i>Hittite Period Expectations</i>	<i>Post-Collapse Expectations</i>
Hattuşa	Evidence for specialized provisioning: spatial separation of butchery and consumption waste	<b>SHIFT</b> to less specialized provisioning: butchery and consumption waste appear together
Çadır Höyük	Depending on local organization during Hittite Period: 1) Evidence for specialized provisioning (separation of butchery and consumption waste) <u>OR</u> 2) Evidence for non-specialized provisioning (butchery and consumption waste appear together)	If 1) <b>NO CHANGE:</b> Evidence for specialized provisioning (separation of butchery and consumption waste) <u>OR</u> If 2) <b>NO CHANGE:</b> Evidence for non-specialized provisioning (butchery and consumption waste appear together)

Table 4.7 Expectations for skeletal parts distributions

At the end of the Late Bronze Age, based on the standard collapse models (see Chapter 3), we would expect that provisioning systems in central Anatolia would likely be disrupted. At Hattuša, we might expect the proportion of butchery waste to increase if more consumers could no longer obtain meat through specialized butchery systems and had to begin butchering animals themselves. These animals could be obtained through direct contract with producers, or consumers might shift to raising the animals themselves. In either case, we would expect a more even distribution of elements representing all parts of the animal carcass to be present.

Expectations for Çadır, on the other hand, depend on how one envisions the relations between capital and province in central Anatolia under Hittite rule. If Hittite political and economic organization involved a strong integration between Hattuša and rural centers like Çadır (Table 4.7a), we would expect that there might be a similar shift away from specialized provisioning systems at Çadır after the Hittite collapse, since disruptions in the broader economic organization would affect capital and provincial sites alike. In contrast, if, as some collapse narratives imply, rural sites like Çadır had always led a fairly independent existence, largely unaffected by the political superstructure, then the collapse of the Hittite empire may have had minimal economic impacts at Çadır, and patterns of provisioning and consumption (whether specialized or not) would likely remain consistent at the site across the transition to the Iron Age (Table 4.7b).

#### *4.5.2 Methods: Quantification of Minimum Number of Elements and of Skeletal Parts Using Minimum Animal Units*

In order for skeletal parts to be analyzed, selected skeletal elements for each of the major taxa were grouped into six body zones (Table 4.8): head, axial, pelvis, forelimb, hindlimb, and extremity. For the head, only the two most commonly occurring/easily identifiable elements,

maxilla and mandible, were included. However, to minimize count inflation due to high degrees of fragmentation (especially of the cheek/alveolus area), mandibles and maxillae without teeth were excluded. Diagnostic loose teeth (e.g. lower dp4; upper and lower M3) were examined, but they did not outnumber maxilla/mandible counts in given sample, and so they were ultimately excluded.

<i>Body Zone</i>	<i>Associated Elements</i>
Head	maxilla, mandible
Axial	atlas, axis, ribs
Pelvis	ilium, ischium, pubis
Forelimb	humerus, radius, ulna, scapula
Hindlimb	femur, tibia
Lower Extremity	carpals, tarsals, metapodials, sesamoids, phalanges

Table 4.8 Elements within each body zone category

Within each body zone, the minimum number of elements (MNE) was calculated for each skeletal element. Following Lyman’s (1994: 42) paraphrase of Binford’s (1984: 50) classic definition, MNE is defined as the “minimum number of individual elements necessary to account for the whole and fragmentary specimens observed.” For the sake of this analysis, this number was obtained by examining the number of diagnostic anatomic parts (Table 4.9) for each element. For example, for long bones, these diagnostic parts included proximal and distal ends/epiphyses and proximal and distal shafts. Following Bunn and Kroll (1986), side was disregarded. Complete specimens were broken down into the diagnostic part categories. The diagnostic anatomic part category with the highest representation was taken as the MNE for a given skeletal element. These MNE values are displayed as bar charts in the results section below.

<i>Element</i>	<i>Diagnostic Anatomic Part</i>
Maxilla and mandible	symphysis/incisor/diastema area; cheek/alveolus; articular process; coronoid process
Atlas and axis	cranial, caudal, medial, lateral, central, spinal/transverse process
Ribs	rib head (proximal rib)
Ilium, ischium, pubis	acetabulum
Scapula, humerus, radius, ulna, femur, tibia, carpals, tarsals, metapodials, sesamoids, phalanges	proximal end, distal end, proximal shaft, distal end

Table 4.9 Diagnostic anatomic parts for each skeletal element

Furthermore, to account for differences in representation between elements that occur with differing frequencies within the body (e.g. cattle have two humeri but eight first phalanges), the highest MNE value for each element was normalized by dividing them by the number of times a given element occurs in the body (e.g. the MNE value of cattle humeri was divided by two, while the MNE of cattle first phalanges was divided by eight). This approach prevents frequently occurring elements from being over-represented in the analysis. These normalized values represent what Binford (1984: 51) calls minimum animal units (MAU). Within each body zone, the element with the highest MAU was taken as representative of that body zone for a given taxon. The relative percentages of these different body zones for each taxon were calculated and are displayed in the form of histograms in the results section below.

Within these figures, the over- or under-representation of each body zone is interpreted in terms of its distance from the “zero” axis. A sample of this kind of histogram is visible in Figure 4.1a. This histogram demonstrates what would happen if, for example, ten cattle were butchered and the heads and extremities of half of them were taken away. The over- or under-representation of each body zone is interpreted in terms of its distance from the “zero” axis. In this hypothetical sample of cattle, the head and extremity regions are under-represented by

around 7%. The remaining body zones (the axial skeleton, pelvis, forelimb, and hindlimb) are over-represented by around 3%.

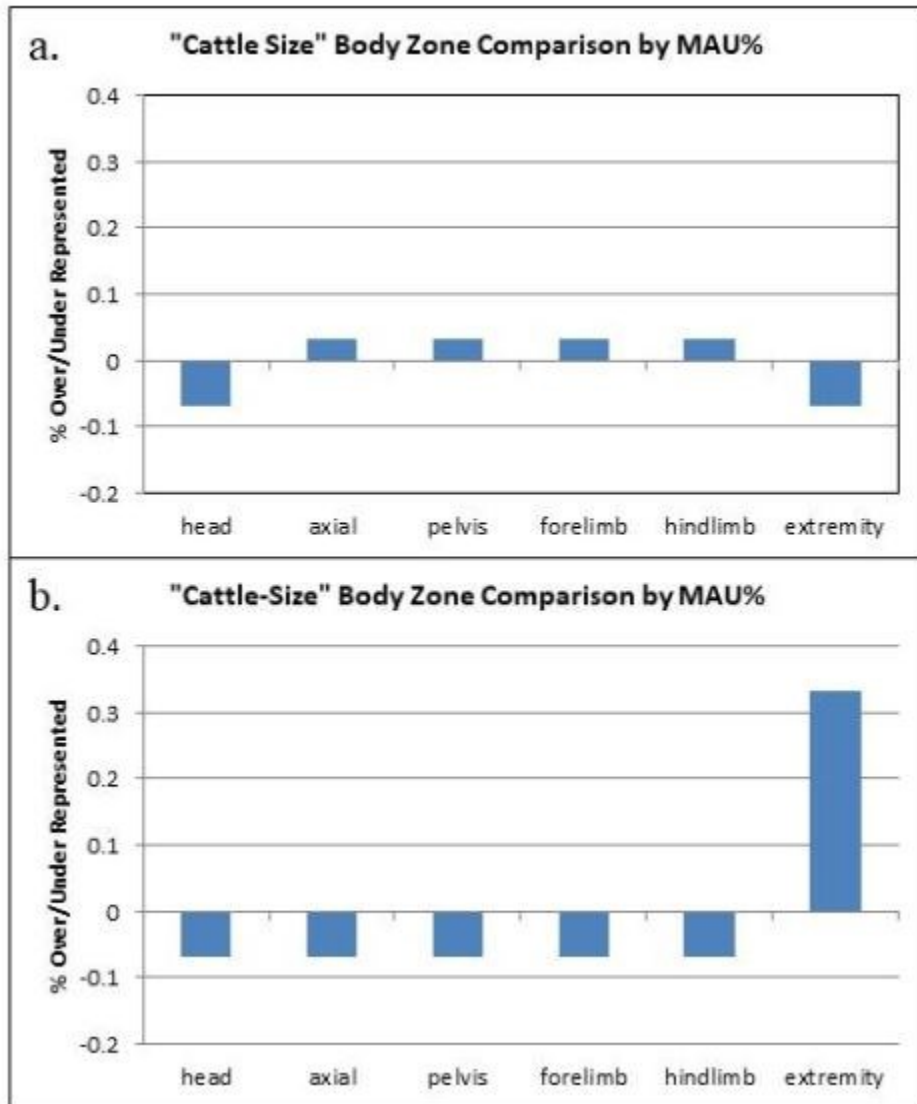


Figure 4.1. Sample distributions of body zones by %MAU

If no specimens are present for a given body zone (i.e. MAU=0), the MAU% is equal to -16.77% (one-sixth of 100%), falling below the zero axis. However, in some cases (particularly if a single body zone is extremely over-represented), percentages can exceed 16.77%. For example,

Figure 4.1b demonstrates what would happen if, out of ten cattle that were butchered, all body parts except the extremities were removed and taken away for eight of them. In this case, the extremity region is over-represented by 33%. All other regions are under-represented by around 7%.

Skeletal part results are presented first for the two most common taxonomic categories: cattle and caprines. For this analysis, the cattle category includes all “cattle-sized” specimens. Given the low frequency of specimens identified as cervids and equids in both the Hattuşa and Çadır assemblages, the cattle category was expanded beyond specimens specifically identified as *Bos* sp. It also includes specimens identified as large mammal and large artiodactyl. Similarly, the caprine category was expanded to include additional “caprine-sized” specimens. This approach was taken due to the limited number of specimens identified as small or medium sized cervids, and the high identifiability of pig specimens. The caprine-sized category includes specimens identified as *Ovis* sp., *Capra* sp., *Ovis* sp./*Capra* sp., medium mammal, medium artiodactyl, and medium bovid/cervid. The cattle-sized and caprine-sized skeletal parts results are followed by those of a handful of other less common taxa: pigs, equids, canids, and cervids.

## **CHAPTER 5**

### **RESULTS: THE MANAGEMENT OF ANIMAL RESOURCES AT HATTUŞA AND ÇADIR HÖYÜK DURING THE BRONZE AND IRON AGES**

Results from the analysis of materials from Hattuşa and Çadır Höyük are presented in this chapter. Results are broken down into sections by the type of information being analyzed: recovery and taphonomy, species frequencies, survivorship and mortality, biometrics, and skeletal parts. Within each section, results from Hattuşa are presented first, organized by excavation area/period. Results are then presented from Çadır Höyük by period. Finally, results from both sites are discussed and compared (where relevant) at the end of each section.

Over the course of fourteen months from 2014-2015, over 6000 faunal specimens from Hattuşa were recorded by the author. The recorded specimens derive from three areas of the site (described in depth in Chapter 2) and date to multiple periods of occupation during the second and first millennia B.C (Table 5.1). Materials were recorded from two areas near the rocky outcropping known as Kesikkaya: Kesikkaya South and Kesikkaya Northwest. The materials recorded from Kesikkaya South date to the Hittite period (Middle Bronze II – Late Bronze II; 1680-1200 BC) and the Middle Iron Age (900-700 BC). The majority of the recorded specimens from Kesikkaya Northwest date to the Karum period and/or the transition from the Karum period to the Hittite period (Middle Bronze I; 1900-1700 BC). A very small number of Hittite period specimens (possibly dating to the early 15<sup>th</sup> century BC [Late Bronze I]) was also recorded from Kesikkaya Northwest. The remainder of the recorded materials came from the “South Area” in the southern Lower Town. These materials date to early in the Hittite period (prior to 1400 BC).

<b>Period</b>	<b>Dates</b>	<b>Boğazköy-Hattuša - Excavation Area</b>
Middle Iron	900-700 BC	Kesikkaya South
Hittite (LB II – MB II)	1680-1200 BC	Kesikkaya South (LB II, LB I, MB II) Kesikkaya Northwest (LB I) Lower Town South (LB I/MBII)
Karum (MB I)	1900-1680 BC	Kesikkaya Northwest (MB I)

Table 5.1 Excavation areas and periods represented at Boğazköy-Hattuša

During approximately seventeen months between 2013 and 2016, over 8,700 faunal specimens from the second to early first millennium at Çadır Höyük were recorded. These materials can be divided into six chronological phases (Table 5.2): Karum period (Middle Bronze I; 1900-1680 BC), Old Hittite Period (Middle Bronze II; 1680/1650-1500 BC), Middle Hittite Period (Late Bronze I; 1500-1400/1380 BC), Hittite Empire/Transitional period (Late Bronze II; 1400/1380-1200 BC), Early Iron (1200-900 BC), and Middle Iron (900-700 BC). The animal bones from the first three periods (MB I and II; LB I) were recovered from the step trench (ST 2, ST 3, ST 7, and ST 8) on the mound's eastern slope. Late Hittite and Iron Age materials were recovered from trench USS 4 on the southern side of the mound (Table 5.2).

<b>Period</b>	<b>Dates</b>	<b>Çadır Höyük - Trench</b>
Middle Iron	900-700 BC	USS 4
Early Iron	1200-900 BC	USS 4
Late Bronze		
LB II-Hittite Empire/Trans.	1400/1380-1200 BC	USS 4
LB I-Middle Hittite	1500-1400/1380 BC	ST 2-3; ST 7-8
Middle Bronze		
MB II-Old Hittite	1680/1650-1500 BC	ST 2-3; ST 7-8
MB I - Karum Period	1900-1680 BC	ST 8

Table 5.2 Excavation areas and periods represented at Çadır Höyük (adapted from Ross et al. 2019, Table 1).

## 5.1 Recovery and Taphonomy

### 5.1.1 *Hattuša Results*

#### 5.1.1.1 Recovery Index

At Hattuša, the relative recovery of first vs. second phalanges varies considerably depending on size (cattle vs. caprine) and period (Table 5.3). In all samples (across all four excavation areas/periods), the recovery index of cattle-sized second phalanges is higher than that of caprine-sized second phalanges. For the Karum/Hittite Transitional sample from Kesikkaya Northwest and the Hittite sample from the Lower Town, South Area, Kesikkaya, the recovery of cattle second phalanges is 60.0% while the cattle second phalanx recovery rate for the Middle Iron Kesikkaya South sample is 81.8%. (The exceedingly high cattle second phalanx recovery rate for the Hittite period Kesikkaya South sample is most likely an artifact of its small sample size.)

Caprine second phalanx recovery is typically much lower, ranging between 20.0-25.0% in three of the samples (Kesikkaya Northwest Karum/Hittite Transitional; Kesikkaya South Hittite; Kesikkaya South Middle Iron). In the Lower Town, South Area, Hittite period assemblage, however, the recovery of caprine second phalanges is much higher, at 66.7%.

The site-wide total frequency of recovery for cattle second phalanges (combining the materials from the four assemblages included in Table 5.3) is 93.1%; when the Hittite period Kesikkaya South sample is excluded, the total frequency is 85.7%. In contrast, the frequency of recovery for caprine second phalanges is 24.0%. These results suggest that smaller elements of medium-sized mammals (caprines in this analysis) are much more likely to have been lost in recovery in these samples than those of larger-bodied animals.

	<b>Hattuša/Kesikkaya NW – Karum/Hittite Trans.</b>		
	1st Phalanx Specimen Count	2nd Phalanx Specimen Count	2 <sup>nd</sup> phalanx/1 <sup>st</sup> phalanx
Cattle	12	6	60.0%
Caprine	19	4	21.1%

	<b>Hattuša/Lower Town, South Area – Hittite</b>		
	1st Phalanx Specimen Count	2nd Phalanx Specimen Count	2 <sup>nd</sup> phalanx/1 <sup>st</sup> phalanx
Cattle	5	3	60.0%
Caprine	8	2	25.0%

	<b>Hattuša/Kesikkaya South – Hittite</b>		
	1st Phalanx Specimen Count	2nd Phalanx Specimen Count	2 <sup>nd</sup> phalanx/1 <sup>st</sup> phalanx
Cattle	1	3	300.0%
Caprine	3	2	66.7%

	<b>Hattuša/Kesikkaya South – Middle Iron</b>		
	1st Phalanx Specimen Count	2nd Phalanx Specimen Count	2 <sup>nd</sup> phalanx/1 <sup>st</sup> phalanx
Cattle	11	9	81.8%
Caprine	20	4	20.0%

Table 5.3 Comparison of survival of cattle and caprine 1<sup>st</sup> phalanx vs. 2<sup>nd</sup> phalanx by specimen count at Hattuša

#### 5.1.1.2 Fragmentation Index

Table 5.4 shows the relative degrees of fragmentation of phalanx 1 and 2 at Hattuša calculated using the ratio of diagnostic zone (DZ) count to specimen count. When the results are compared across periods (in the “Total Site” column) caprine and cattle second phalanges have the lowest degree of fragmentation (with DZ to specimen count indices of 1.92 and 1.90 respectively).

	Total Site	Kesikkaya NW Karum/Hittite Trans.	Lower Town South Area Hittite	Kesikkaya South Hittite	Kesikkaya South Middle Iron
Cattle Ph 1 DZ	49	20	9	2	18
Cattle Ph 1 Count	29	12	5	1	11
<b>Cattle Ph 1 DZ/Count</b>	<b>1.69</b>	<b>1.67</b>	<b>1.80</b>	<b>2.00</b>	<b>1.64</b>
Cattle Ph 2 DZ	40	12	6	6	16
Cattle Ph2 Count	21	6	3	3	9
<b>Cattle Ph2 DZ/Count</b>	<b>1.90</b>	<b>2.00</b>	<b>2.00</b>	<b>2.00</b>	<b>1.78</b>
Caprine Ph 1 DZ	66	37	9	2	18
Caprine Ph 1 Count	36	19	5	1	11
<b>Caprine Ph 1 DZ/Count</b>	<b>1.83</b>	<b>1.95</b>	<b>1.80</b>	<b>2.00</b>	<b>1.64</b>
Caprine Ph 2 DZ	23	8	4	4	7
Caprine Ph 2 Count	12	4	2	2	4
<b>Caprine Ph 2 DZ/Count</b>	<b>1.92</b>	<b>2.00</b>	<b>2.00</b>	<b>2.00</b>	<b>1.75</b>

Table 5.4 Comparison of survival of cattle and caprine 1<sup>st</sup> phalanx vs. 2<sup>nd</sup> phalanx at Hattuša, by ratio of diagnostic zone (DZ) count to specimen count

For first phalanges, the averages across periods are somewhat lower (1.83 for caprines and 1.69 for cattle), but they are not extremely low. The highest degree of fragmentation occurs with cattle and caprine first phalanges at Middle Iron Age Kesikkaya South (1.64 for both). For the most part, however, the degree of fragmentation of first and second phalanges, regardless of body size, is fairly low. In other words, these elements tend to have a relatively high degree of completeness, suggesting that they were minimally affected by taphonomic processes after deposition, at least in terms of fragmentation.

### 5.1.1.3 Indices of Taphonomic Loss

When medium mammal specimen completeness is combined for all excavation areas/time periods for Hattuša (Table 5.5), specimens in the “4” (75-99% complete) and “5”

(complete) categories make up the vast majority of medium mammal astragali 96.8% combined). Only one medium mammal astragalus specimen falls outside of these two fragmentation categories. The average completeness index for medium mammal astragali is 4.35, which falls between the two highest completeness categories (4 and 5). In the case of medium mammal second phalanges, the results are similar, with all specimens falling in the “4” (75-99% complete) and “5” (complete). In other words, all medium mammal second phalanges in the Hattuša samples are at least 75% complete. The average completeness index for medium mammal second phalanges is very high, at 4.57. Generally speaking, these results suggest a relatively minimal impact from natural taphonomic processes on the samples in question from Hattuša.

	<b>Hattuša Medium Mammal</b>			
	astragalus		2nd phalanx	
<i>degree of fragmentation</i>	<i>count</i>	<i>%</i>	<i>count</i>	<i>%</i>
complete (5)	12	38.7%	11	78.6%
75%-99% complete (4)	18	58.1%	3	21.4%
50-75% complete (3)	1	3.2%	0	0.0%
25-50% complete (2)	0	0.0%	0	0.0%
0-25% complete (1)	0	0.0%	0	0.0%
<b>avg. completeness index</b>	<b>4.35</b>		<b>4.57</b>	

Table 5.5 Hattuša index of taphonomic loss based on degree of completeness of medium mammal astragalus and 2<sup>nd</sup> phalanx

When we examine the frequency of proximal humeri at Hattuša as a proxy measure for the impact of attrition related to element density, the results show a strong correlation between density and survival/recovery. The frequencies of proximal humerus specimens range from 12.5% (Kesikkaya South, Hittite) to 25.9% (Lower Town, South Area, Hittite) of the total number of proximal and distal humerus specimens (Table 5.6). The combined frequency across

all excavation areas/periods at the site is 16.6%. As noted above, if the survival of proximal and distal humeri was equal, the frequency of proximal humeri would be 50%. This frequency of proximal humeri is very low.

The frequency of proximal tibiae tends to somewhat be higher. The frequencies of proximal tibia specimens range from 11.9% (Kesikkaya South, Middle Iron) to 39.7% (Kesikkaya Northwest, Karum/Hittite Trans.) of the total number of proximal and distal tibia specimens (Table 5.6). The combined frequency across all periods at the site is 27.7%, suggesting that tibiae are less intensely affected by density mediated attrition at Hattuša than humeri, but that they are still strongly affected.

	<b>Total Site</b>	<b>Kesikkaya NW Karum/Hittite Trans.</b>	<b>Lower Town, South Area Hittite</b>	<b>Kesikkaya South Hittite</b>	<b>Kesikkaya South Middle Iron</b>
pxHumerus	24	8	7	1	8
dsHumerus	121	47	20	7	47
Total	145	55	27	8	55
%pxHumerus	16.6%	14.5%	25.9%	12.5%	14.5%
pxTibia	36	23	7	1	5
dsTibia	94	35	17	5	37
Total	130	58	24	6	42
%pxTibia	27.7%	39.7%	29.2%	16.7%	11.9%

Table 5.6 Frequency of proximal humerus and proximal tibia compared to the number of specimens of both ends for those elements at Hattuša.

#### 5.1.1.4 Modifications

The impacts of carnivore/rodent gnawing on the materials from Hattuša appear to be extremely minimal (Table 5.7). Specimens with evidence for carnivore/rodent gnawing and/or digestion ranges comprise at most 1.8% of the assemblage (during the Karum/Hittite Trans.

period at Kesikkaya Northwest). Specimens with signs of digestion are very rare as are specimens with signs of rodent gnawing. These categories are only present at Karum/Hittite Transitional period Kesikkaya Northwest, and in both of these cases, they comprise < 0.1% of the sample. These results suggest that trash at Hattuša was disposed of in such a way that dogs and other scavengers had little access to it.

	Kesikkaya NW Karum/Hittite Trans.		Lower Town, South Area Hittite		Kesikkaya South Hittite		Kesikkaya South Middle Iron	
	<i>Count</i>	<i>%</i>	<i>Count</i>	<i>%</i>	<i>Count</i>	<i>%</i>	<i>Count</i>	<i>%</i>
no modification	2455	98.2%	1450	99.1%	419	98.8%	1375	100.0%
carnivore gnawed	40	1.6%	13	0.9%	5	1.2%	0	0.0%
rodent gnawed	2	0.1%	0	0.0%	0	0.0%	0	0.0%
digested	2	0.1%	0	0.0%	0	0.0%	0	0.0%

Table 5.7 Modifications from carnivores/rodents by period at Hattuša.

Analysis of the presence/absence of evidence for burning at Hattuša appears in Table 5.8. Across time periods, the majority of specimens are unburned. The Kesikkaya Northwest Karum/Hittite Transitional sample has the highest incidence of burned specimens, with 6.9% of specimens showing signs of burning. The presence of burned specimens at Kesikkaya South and the Lower Town, South Area ranges from 3.5-5%. Generally speaking, then, the exposure to heat in the samples from Hattuša seems to have been relatively minor. Signs of exposure to high heat (white/grey, partially white/grey, carbonized and white/grey) are very limited (0.2% or less in all samples). The limited exposure to high heat, which can result in a high degree of fragmentation/distortion (Orton 2011), along with the low incidence of burning overall, suggests that heat exposure was not a major taphonomic factor for the Hattuša materials included here.

	<b>Kesikkaya NW Karum/Hittite Trans.</b>		<b>Lower Town, South Area Hittite</b>		<b>Kesikkaya South Hittite</b>		<b>Kesikkaya South Middle Iron</b>	
	<i>Count</i>	<i>%</i>	<i>Count</i>	<i>%</i>	<i>Count</i>	<i>%</i>	<i>Count</i>	<i>%</i>
unburned	2352	93.1%	1413	96.5%	407	95.8%	1627	95.0%
carbonized	10	0.4%	0	0.0%	0	0.0%	6	0.4%
partially carbonized	160	6.3%	49	3.3%	17	4.0%	79	4.6%
white/grey	1	0.0%	0	0.0%	0	0.0%	0	0.0%
partially white/grey	2	0.1%	3	0.2%	0	0.0%	0	0.0%
carbonized and white/grey	0	0.0%	0	0.0%	1	0.2%	1	0.1%

Table 5.8 Evidence of burning by period at Hattuša

#### 5.1.1.5 Hattuša Recovery and Taphonomy Summary

To summarize, the results above suggest that at Hattuša, smaller elements are more likely to be missed in recovery and have a lower recovery rate than larger elements. When a comparison was made of the recovery of cattle and caprine second phalanges, the rate of recovery for cattle second phalanges was quite good. However, the recovery rate of caprine second phalanges was considerably lower. This suggests that the smaller elements of medium-sized mammals (caprines in the analysis described above) are more likely to be lost in recovery than those of larger-bodied animals (e.g. cattle).

Regarding potential taphonomic biases, small, dense elements (e.g. first and second phalanges and astragali, discussed in the fragmentation index and indices of taphonomic loss sections above), which would be unlikely to be fragmented due to butchery/processing activities, do not display a high degree of fragmentation, suggesting that they were minimally affected by taphonomic processes that would result in fragmentation. However, there is evidence for a high

degree of density-mediated attrition, as evidenced by the frequencies of proximal humeri and tibiae discussed above. Evidence for carnivore gnawing and burning is relatively rare.

### *5.1.2 Çadır Höyük Results*

#### 5.1.2.1 Recovery Index

At Çadır, the relative recovery of first vs. second phalanges varies considerably depending on size (cattle vs. caprine) and period (Table 5.9). For the Hittite period materials, the recovery of cattle second phalanges is decent (71.4% of first phalanges). Unsurprisingly, caprine second phalanx recovery is lower (52.2% of first phalanges). For the Early Iron Age materials, the recovery of cattle second phalanges is extremely high (120% of first phalanges), which may be an artifact of small sample size. Caprine second phalanx recovery is much lower (30% of first phalanges). Within the Middle Iron Age sample, the recovery of cattle second phalanges is low (33.37% of first phalanges). Curiously, however, the recovery of caprine second phalanges is quite high relative to first phalanges (86.7%). The site-wide total frequency of cattle second phalanges (including the materials from the Hittite period through the Middle Iron Age) is 69%, while the frequency for caprine second phalanges is 58.3%. Generally speaking, these results suggest that, regardless of body size, smaller elements are more likely to be missed in recovery, and have a lower recovery rate than larger specimens at Çadır. The results also indicate that smaller elements of medium-sized mammals (caprines in this example) are more likely to be lost in recovery than those of larger-bodied animals.

	<b>Çadır Hittite (MB II, LB I, LB II)</b>		
	1st Phalanx Specimen Count	2nd Phalanx Specimen Count	2 <sup>nd</sup> phalanx/1 <sup>st</sup> phalanx
Cattle	28	20	71.4%
Caprine	23	12	52.2%

	<b>Çadır Early Iron</b>		
	1st Phalanx Specimen Count	2nd Phalanx Specimen Count	2 <sup>nd</sup> phalanx/1 <sup>st</sup> phalanx
Cattle	5	6	120.0%
Caprine	10	3	30.0%

	<b>Çadır Middle Iron</b>		
	1st Phalanx Specimen Count	2nd Phalanx Specimen Count	2 <sup>nd</sup> phalanx/1 <sup>st</sup> phalanx
Cattle	9	3	33.3%
Caprine	15	13	86.7%

Table 5.9 Comparison of survival of cattle and caprine 1<sup>st</sup> phalanx vs. 2<sup>nd</sup> phalanx by specimen count at Çadır Höyük

#### 5.1.2.2 Fragmentation Index

Table 5.10 shows the relative degrees of fragmentation of first and second phalanges at Çadır calculated using the ratio of diagnostic zone (DZ) count to specimen count. When the results are compared across periods (in the “Total Site” column), caprine and cattle second phalanges have a lower degree of fragmentation than first phalanges (with DZ to specimen count indices of 1.93 and 1.90 respectively). For first phalanges, the averages across periods are somewhat lower (1.73 for caprines and 1.69 for cattle), but they are not extremely low. The highest degree of fragmentation occurs with cattle first phalanges in the Iron Age (1.40 in the Early Iron and 1.56 in the Middle Iron). For the most part, however, the degree of fragmentation of first and second phalanges, regardless of body size, is fairly low. In other words, these

elements tend to have a relatively high degree of completeness, suggesting that they were minimally affected by taphonomic processes after deposition, at least in terms of fragmentation.

	Total Site	Hittite	Early Iron	Middle Iron
Cattle Ph 1 DZ	71	50	7	14
Cattle Ph 1 Count	42	28	5	9
<b>Cattle Ph 1 DZ/Count</b>	<b>1.69</b>	<b>1.79</b>	<b>1.40</b>	<b>1.56</b>
Cattle Ph 2 DZ	55	37	12	6
Cattle Ph2 Count	29	20	6	3
<b>Cattle Ph2 DZ/Count</b>	<b>1.90</b>	<b>1.85</b>	<b>2.00</b>	<b>2.00</b>
Caprine Ph 1 DZ	83	40	16	27
Caprine Ph 1 Count	48	23	10	15
<b>Caprine Ph 1 DZ/Count</b>	<b>1.73</b>	<b>1.74</b>	<b>1.60</b>	<b>1.80</b>
Caprine Ph 2 DZ	54	22	6	26
Caprine Ph 2 Count	28	12	3	13
<b>Caprine Ph 2 DZ/Count</b>	<b>1.93</b>	<b>1.83</b>	<b>2.00</b>	<b>2.00</b>

Table 5.10 Comparison of survival of cattle and caprine 1<sup>st</sup> phalanx vs. 2<sup>nd</sup> phalanx at Çadır Höyük by ratio of diagnostic zone (DZ) count to specimen count

### 5.1.2.3 Indices of Taphonomic Loss

Combining all time periods at Çadır Höyük from the Karum period (Middle Bronze I) through Middle Iron, specimens in the “4” (75-99% complete) and “5” (complete) categories make up the vast majority of medium mammal astragali (88.5% combined) (Table 5.11). The average completeness index for medium mammal astragali is 4.29, which falls between the two highest completeness categories. In the case of medium mammal second phalanges, results are similar, with specimens in the “4” (75-99% complete) and “5” (complete) categories in the majority (88.6%). The average completeness index for medium mammal second phalanges is higher, at 4.57. For both elements (astragali and second phalanges), only one specimen falls into

the “1” category (0-25% complete). Generally speaking, these results suggest a relatively minimal impact from natural taphonomic processes on the samples in question from Çadır.

	<b>Çadır Medium Mammal</b>			
	astragalus		2nd phalanx	
<i>degree of fragmentation</i>	<i>count</i>	<i>%</i>	<i>count</i>	<i>%</i>
complete (5)	24	46.2%	26	74.3%
75%-99% complete (4)	22	42.3%	5	14.3%
50-75% complete (3)	4	7.7%	3	8.6%
25-50% complete (2)	1	1.9%	0	0.0%
0-25% complete (1)	1	1.9%	1	2.9%
<b>avg. completeness index</b>	<b>4.29</b>		<b>4.57</b>	

Table 5.11 Çadır Höyük index of taphonomic loss based on degree of completeness of medium mammal astragalus and 2<sup>nd</sup> phalanx

When we examine the frequency of proximal humeri at Çadır as a proxy measure for the impact of attrition related to element density, the results show a clear correlation between density and survival/recovery. The frequencies of proximal humerus specimens range from 18.2% (Early Iron) to 32.6% (Hittite) of the total number of proximal and distal humerus specimens (Table 5.12), excluding the results from the Karum period, where sample size is small. The combined frequency across all periods at the site is 27.2%. If the survival of proximal and distal humeri was equal, the frequency of proximal humeri would be 50%. Instead it is much lower.

	<b>Total Site</b>	<b>Karum</b>	<b>Hittite</b>	<b>Early Iron</b>	<b>Middle Iron</b>
pxHumerus	25	0	14	2	9
dsHumerus	67	3	31	9	24
Total	92	3	43	11	33
%pxHumerus	27.2%	0.0%	32.6%	18.2%	27.3%
pxTibia	41	3	16	8	14
dsTibia	56	5	21	11	19
Total	97	8	37	19	33
%pxTibia	42.3%	37.5%	43.2%	42.1%	42.4%

Table 5.12 Frequency of proximal humerus and proximal tibia compared to the number of specimens of both ends for those elements at Çadır Höyük

On the other hand, the frequency of proximal tibiae tends to be higher. The frequencies of proximal tibia specimens range from 37.5% (Karum period) to 43.2% (Hittite) of the total number of proximal and distal tibia specimens (Table 5.12). The combined frequency across all periods at the site is 42.3%, suggesting that tibiae are less affected by density mediated attrition at Çadır than humeri.

#### 5.1.2.4 Modifications

The impacts of carnivore/rodent gnawing on the materials from Çadır Höyük appear to be quite minimal (Table 5.13). Regardless of time period, the percentage of materials showing signs of carnivore gnawing is never more than 1.3%. Only four specimens out of well over 8000 (< 0.1%) show signs of digestion. Similarly, only one specimen in the entire assemblage shows signs of rodent gnawing. These results suggest that trash at Çadır was disposed of in such a way that dogs and other scavengers had little access to it.

	Karum Period (MB I)		Hittite (MB II, LB I, LB II)		Early Iron		Middle Iron	
	<i>Count</i>	%	<i>Count</i>	%	<i>Count</i>	%	<i>Count</i>	%
no modification	440	98.7%	4580	98.6%	2105	99.0%	1375	100.0%
carnivore gnawed	6	1.3%	61	1.3%	19	0.9%	0	0.0%
rodent gnawed	0	0.0%	0	0.0%	1	0.0%	0	0.0%
digested	0	0.0%	3	0.1%	1	0.0%	0	0.0%

Table 5.13 Modifications from carnivores/rodents by period at Çadır Höyük.

Analysis of the presence/absence of evidence for burning appears in Table 5.14. Across time periods, the majority of specimens are unburned, with 10% or fewer of all specimens in each period showing evidence of burning. The Early Iron Age materials display the highest evidence for heat exposure. 89.8% of these materials are unburned, while 5.9% are carbonized or partially carbonized, and 4.4% show evidence of exposure to high heat (white/grey, partially white/grey, or carbonized and white/grey). These results align with the interpretation of industrial activities involving high heat taking place in USS-4 (Ross et al. 2019), where these materials were recovered, during the Iron Age. In all other periods (Karum, Hittite, Middle Iron), the frequencies of specimens with exposure to high heat are much lower.

	Karum Period (MB I)		Hittite (MB II, LB I, LB II)		Early Iron		Middle Iron	
	<i>Count</i>	%	<i>Count</i>	%	<i>Count</i>	%	<i>Count</i>	%
unburned	436	97.8%	4247	91.5%	1918	89.8%	1365	93.7%
carbonized	0	0.0%	112	2.4%	46	2.2%	66	4.5%
partially carbonized	10	2.2%	271	5.8%	80	3.7%	25	1.7%
white/grey	0	0.0%	7	0.2%	77	3.6%	1	0.1%
partially white/grey	0	0.0%	2	0.0%	8	0.4%	0	0.0%
carbonized and white/grey	0	0.0%	5	0.1%	8	0.4%	0	0.0%

Table 5.14 Evidence of burning by period at Çadır Höyük

#### 5.1.2.5 Çadır Recovery and Taphonomy Summary

To summarize, the results above suggest that at Çadır, smaller elements are more likely to be missed in recovery and have a lower recovery rate than larger elements. Additionally, the smaller elements of medium-sized mammals (caprines in the analysis described above) are more likely to be lost in recovery than those of larger-bodied animals (e.g. cattle).

Regarding potential taphonomic biases, small, dense elements (e.g. first and second phalanges and astragali, discussed in the fragmentation index and indices of taphonomic loss sections above), which would be unlikely to be fragmented due to butchery/processing activities, do not display a high degree of fragmentation, suggesting that they were minimally affected by taphonomic processes that would result in fragmentation. However, there is evidence for density-mediated attrition, particularly with regard to the analysis of proximal humeri. Evidence for carnivore gnawing and burning is relatively rare.

## **5.2 Species Frequencies**

### *5.2.1 Hattuša Results (Kesikkaya Northwest, Kesikkaya South, Lower Town South Area)*

#### 5.2.1.1 General Overview

An overview of the NISP (Number of Identified Specimens) values for Karum/Hittite Transitional Kesikkaya Northwest, Hittite and Middle Iron Kesikkaya South, and Hittite Lower Town, South Area at Hattuša is presented in Table 5.15. The vast majority of the recorded materials are mammalian. These assemblages are dominated by the four major Near Eastern “barnyard” domesticates: sheep (*Ovis aries*), goat (*Capra hircus*), cattle (*Bos taurus*), and pigs (*Sus scrofa*). Of these, caprines (sheep and goats) are typically the most dominant here (N=980 across all excavation areas/periods), followed by cattle (N=304 across all excavation

areas/periods) and more distantly by pigs (N=213 across all excavation areas/periods). Beyond these four taxa, other animals are relatively rare. In terms of the other domesticates, equids (N=16), mostly donkey-sized, also appear in small numbers at Kesikkaya Northwest (Karum/Hittite Transitional Period [MB I]) and Kesikkaya South (Middle Iron). They are absent from the Hittite assemblages included here, though they appear during the Hittite period elsewhere on the site (e.g. at Büyükkaya [von den Driesch and Pöllath 2004] and at the original Lower Town excavations [von den Driesch and Boessneck 1981]). Dogs (*Canis familiaris*) are also present in small numbers in these assemblages (N=17).

Of the wild taxa, deer are the most numerous across these assemblages. Most of these specimens were identified as red deer (*Cervus elaphus*; N=24), but several smaller individuals (either fallow deer [*Dama dama*] or roe deer [*Capreolus capreolus*]; N=3) are also present. Hare (*Lepus capensis*) is the second-most common wild taxon (N=20). Large predators are also present in small numbers. Brown bears (*Ursus arctos*) appear in the Karum Period/Hittite Transitional (MB I) assemblage from Kesikkaya Northwest (N=8). Several large felids were present as well (N=3). One of these, also from the Karum Period/Hittite Transitional material at Kesikkaya Northwest, appeared morphologically very similar to cheetah (*Acinonyx jubatus*) specimens housed at the Field Museum in Chicago, Illinois. Foxes (*Vulpes* sp.) (N=3) and rodents (N=3) were also recovered in small numbers across the assemblages. Non-mammalian animals (birds [N=12] and fish [N=2]) were also represented.

ID	Kesikkaya Northwest - Karum/ Hittite Trans. (MBI)	Lower Town South Area - Early Hittite (MBII/LBI)	Kesikkaya Northwest - Middle Hittite (LB I)	Kesikkaya South - Hittite (MBII-LBII)	Kesikkaya South – Middle Iron	Grand Total
Unidentified	654	386	8	111	431	1590
Small mammal	5	0	0	1	6	12
Medium mammal	694	400	4	116	366	1580
Large mammal	405	175	2	41	328	951
Medium artiodactyl	23	8	0	0	1	32
Large artiodactyl	34	15	0	2	48	99
<i>Ovis/Capra</i>	274	216	7	26	201	724
<i>Ovis aries</i>	87	33	0	5	58	183
<i>Capra hircus</i>	29	11	1	3	29	73
Medium bovid/cervid	83	89	0	12	96	280
<i>Bos taurus</i>	94	89	0	3	118	304
Medium cervid	1	0	0	0	2	3
Large cervid	12	1	0	0	11	24
<i>Sus scrofa</i>	89	39	0	3	82	213
Small/medium equid	5	0	0	0	6	11
Large equid	2	0	0	0	1	3
<i>Equus</i> sp.	0	0	0	0	2	2
Large carnivore	1	0	0	0	0	1
Large felid	0	0	0	1	1	2
<i>cf. Acinonyx jubatus</i>	1	0	0	0	0	1
Medium canid	4	1	0	0	12	17
<i>Vulpes</i> sp.	1	1	0	0	1	3
<i>Ursus arctos</i>	8	0	0	0	0	8
Rodentia	0	0	0	0	2	2
<i>Spalax</i> sp.	0	0	0	0	1	1
<i>Lepus</i> sp	9	0	0	2	9	20
Pisces	2	0	0	0	0	2
Aves	8	1	0	2	1	12
	<b>2525</b>	<b>1465</b>	<b>22</b>	<b>328</b>	<b>1813</b>	<b>6153</b>

Table 5.15 Taxonomic identifications in the second to first millennium BC stratigraphic sequence at Hattuša (based on Number of Identified Specimens - NISP).

### 5.2.1.2 Species Frequencies by NISP, Weight, and Diagnostic Zone

#### *Number of Identified Specimens (NISP)*

At Kesikkaya Northwest during the Karum/Hittite Transitional Period (Fig. 5.1a), caprines dominate the assemblage (%NISP=66.6%) when species frequencies are calculated by NISP. Caprines are followed by cattle and pigs in relatively equal proportions (%NISP=13.2% and 12.5% respectively). These primary taxa are followed distantly by the “other” category (%NISP=4.2%), which in this case includes bears, hares, foxes, fish and birds; deer (%NISP=1.8%); equids (%NISP=1.0%); and dogs (%NISP=0.6%).

At Lower Town South during the Hittite period (Fig. 5.1a), caprines dominate the assemblage when species frequencies are calculated by NISP (%NISP=72.6%). Cattle are the second-most abundant taxon (%NISP=18.5%), followed by pigs (%NISP=8.2%). These primary taxa are followed very distantly in order of abundance by the “other” category (%NISP=4.2%), which in this case represents foxes and birds; dogs (%NISP=0.2%) and deer (%NISP=0.2%). Equids are completely absent.

At Hittite Kesikkaya South (Fig. 5.1a), caprines are by far the most abundant taxon when species frequencies are calculated by NISP (%NISP=80.7%). Caprines are followed by the “other” category, which in this case represents hares and birds. The next-most abundant animals are cattle (%NISP=5.3) and pigs (%NISP=5.3). Dogs, deer, and equids are absent.

The Middle Iron Age assemblage at Kesikkaya South (Fig. 5.1a) is dominated by caprines (%NISP=60.7%). Cattle have the second-highest frequency (%NISP=18.6%) followed by pigs (%NISP=13.0%). The “other” category is the next-most abundant group (%NISP=2.4%), in this case representing large felids, foxes, rodents, hares, and birds. The least-most abundant

taxonomic categories are deer (%NISP=2.1%), dogs (%NISP=1.9%), and equids (%NISP=1.4%).

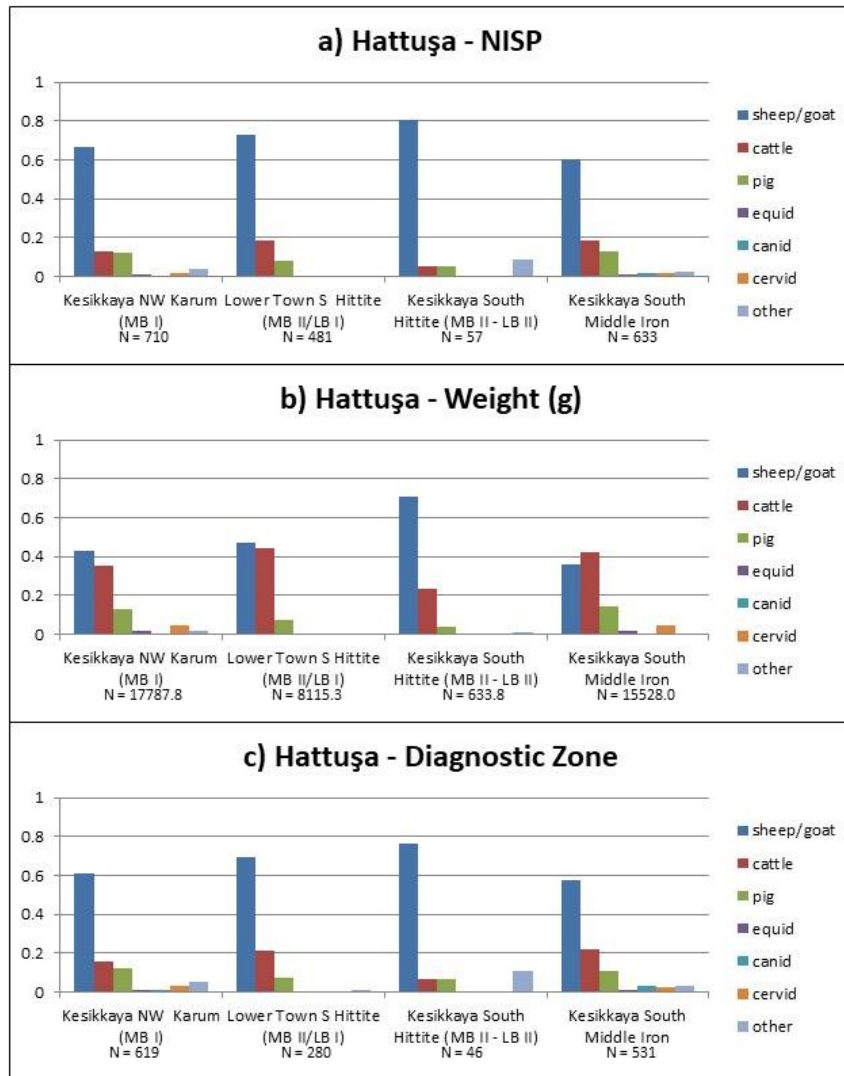


Figure 5.1. Percentage of primary taxa at Hattuša.

### Weight (g)

When the Karum/Hittite Transitional Period materials at Kesikkaya Northwest are examined by weight (g) (Fig. 5.1b), caprines dominate (%weight=42.7%), followed by cattle (%weight=35.5%). Pigs have the next greatest abundance (%weight=12.9%), followed by deer (%weight=4.7%), the “other” category (%weight=2.1%), and dogs (%weight=0.2%).

At the Hittite Lower Town, South Area (Fig. 5.1b), caprines and cattle make up the bulk of the assemblage when measured by weight (respectively, %weight=47.4% and 44.4%). Pigs have the next greatest representation by weight (%weight=7.6%). Deer, dogs, and the “other” category are present in very low frequencies (each less than 1% by weight percentage).

When the Hittite Kesikkaya South assemblage is examined by weight (g) (Fig. 5.1b), caprines are the most abundant animals (%weight=71.0%). They are followed by cattle (%weight=23.7%), and the “other” category (%weight=1.3%).

For the Middle Iron assemblage at Kesikkaya South (Fig. 5.1b), cattle are the most abundant taxon by weight (%weight=42.1%). Cattle are followed in abundance by caprines (%weight=35.8%) and pigs (%weight=14.1%). Deer appear at a much lower frequency (%weight=4.8%) as do equids (%weight=2.2%). Dogs and the “other” category both are present in very low frequency (for both %weight<1%).

### Diagnostic Zone (DZ)

Caprines are the most abundant when the Karum/Hittite Transitional assemblage from Kesikkaya Northwest is examined by diagnostic zone (%DZ=61.1%) (Fig. 5.1c). They are followed in abundance by cattle (%DZ=15.7%) and pigs (%DZ=12.0%). The less-represented

taxa include the “other” category (%DZ=5.6%), deer (%DZ=3.1%), equids (%DZ=1.3%), and dogs (%DZ=1.3%).

When the Hittite assemblage from the Lower Town, South Area, is examined by diagnostic zone (Fig. 5.1c), caprines have the highest frequency (%DZ=69.6%). They are followed in abundance by cattle (%DZ=21.4%) and pigs (%DZ=7.1%). The “other” category has a very low representation (%DZ=1.1%), and the frequency of deer is especially low (%DZ=0.7%). Dogs and equids are absent.

During the Hittite period at Kesikkaya South, the frequency of caprines is very high (%DZ=76.1%) when examined by diagnostic zone (Fig. 5.1c). The “other” category has the second-highest frequency (%DZ=10.9%). Cattle and pigs are also present in low frequencies (for both, %DZ=6.5%). Dogs, deer, and equids are absent.

During the Middle Iron Age at Kesikkaya South (Fig. 5.1c), caprines have the highest frequency (%DZ=57.3%). Cattle are the second most frequent taxon in the assemblage (%DZ=22.2%), followed by pigs (%DZ=10.7%). Animals in the “other” category are present in low frequencies (%DZ=3.2%), as are dogs (%DZ=3.0), deer (%DZ=2.6%), and equids (%DZ=0.9%).

### 5.2.1.3 Discussion of Hattuša Species Frequencies

When species frequencies calculated using NISP are compared across the different excavation areas and time periods at Hattuša (Fig. 5.1a) several trends related to animal management strategies become apparent. In all areas/periods, caprines are the most abundant animals by far, ranging from 81% (Hittite period, Kesikkaya South) to 61% (Middle Iron Age, Kesikkaya South) of the total assemblages. Cattle, the second most prominent taxon in these

assemblages, never surpass 20% of the total sample, regardless of excavation area or period. In two cases, during the Karum/Hittite transitional period at Kesikkaya Northwest and during the Hittite period at Kesikkaya South, the representation of cattle is equal to that of pigs. In all of these samples, the percentage of equids, canids, and cervids is quite low (<6% by NISP). In the case of Kesikkaya South during the Hittite period, these taxa are completely absent.

When the assemblages are compared temporally, a few major differences in species distributions are apparent across time. Among the Karum/Hittite Transitional materials from Kesikkaya Northwest, caprines dominate (%NISP=67% of the overall sample), followed by cattle and pigs in much smaller relative proportions (%NISP=approximately 13% each). Equids, canids, and cervids comprise a very small percentage of the materials here (%NISP=approximately 1-2% each), and “other” taxa (all wild) make up around four percent. When examining the Hittite materials from Lower Town South, the trends are generally similar: mostly caprines, followed by cattle and pigs, with a smattering of specimens from other taxa. The same applies to the Middle Iron assemblage from Kesikkaya South.

The species distributions of the Hittite materials from Kesikkaya South, on the other hand, differ somewhat. The proportion of caprines in this assemblage is higher than any of the other three assemblages under consideration (%NISP=81% as opposed to approx. 60-65%), while the cattle and pig proportions are lower than in the other cases (%NISP=approx. 5% each). At the same time, the “other” category is highest at Hittite Kesikkaya South (%NISP=almost 10%), and one of the specimens included here belongs to a juvenile big cat. While these differences from the patterns represented in the other assemblages may be attributable to sample size, they may also point toward differences in the kinds of activities taking place in this area of Hattuša during this period. The very high proportion of caprines at Hittite Kesikkaya South could

relate to intensified wool production. The very low percentages of cattle and pigs other taxa at Kesikkaya South during this time relative to the other samples (along with the complete absence of other relatively common taxa such as canids, equids, and cervids) could likewise indicate that this area of the site was focused on activities surrounding the caprine secondary products. On the other hand, the high proportion of caprines at Kesikkaya South during the Hittite period could also point toward a situation in which this area of the site was being provisioned with caprines for meat consumption, which would explain the abundance of caprines and the general lack of other taxa.

When species frequencies are calculated by bone weight (Fig. 5.1b) rather than fragment count, the importance of cattle in these assemblages is emphasized. Using bone weight as a proxy for meat weight (Uerpmann 1973), the relative proportions of caprines and cattle tend to even out in most of the samples (the exception being the Kesikkaya South Hittite period assemblage). While we typically associate animal economies in ancient Anatolia and the Near East more broadly as being based on sheep/goat pastoralism, these proportions underscore the importance of cattle as potential sources of both economic and symbolic value (Arbuckle 2014) in ancient central Anatolia.

The results for Hittite period Kesikkaya South (Fig. 5.1b) show that even when the differing body weights of cattle and caprines are taken into account, caprines (%weight=71%) still appear in far greater proportion than cattle (%weight=25%) in this sample, supporting the interpretation that caprines played an important role at Kesikkaya South during the Hittite period. In contrast, the “other” category from Hittite Kesikkaya South becomes completely de-emphasized because it contains mostly small mammals such as hare.

Finally, calculating the species frequencies for these assemblages by diagnostic zone (Fig. 5.1c) yields species distributions that are quite similar in shape to the ones produced when calculating by NISP (Fig. 5.1a). As was the case with NISP, caprines comprise by far the most abundant animal category, followed distantly by cattle and pigs. Likewise, as was the case with NISP, caprines are extremely well-represented compared to other taxa at Hittite period Kesikkaya South. The general consistency between NISP and DZ results (which use two different methods of calculation), serves as a confirmation that the patterns in the species distributions are actual and not an artifact of the particular method of quantification.

#### 5.2.1.4 Hattuša Sheep to Goat Ratios

Sheep to goat ratios (Table 5.16) were examined for faunal materials from Kesikkaya South, Kesikkaya Northwest, and Lower Town South. The Hittite period materials from Kesikkaya South and Kesikkaya Northwest were not included due to sample size. Calculations were made using NISP. At Kesikkaya Northwest during the Karum/Hittite Transitional period, the ratio of sheep to goats is 3:1. The same is the case during the Hittite period at the Lower Town, South Area. This sheep to goat ratio is high and could be linked to an emphasis on wool production (Redding 1984). During the Middle Iron Age at Kesikkaya South, the sheep to goat ratio is lower, 2:1. This lower sheep to goat ratio could be suggestive on a reduced emphasis on intensive fiber production at in this area of the site during the Iron Age.

area	Kesikkaya NW	Lower Town S	Kesikkaya S
period	<i>Karum/Hittite Trans</i>	<i>Hittite</i>	<i>Middle Iron</i>
sheep	87	33	58
goat	29	11	29
sheep:goat	3.00	3.0	2.0

Table 5.16 Comparison of sheep to goat ratios at Hattuša.

#### 5.2.1.5 Hattuša Summary

When the four samples from Hattuša are compared across the Bronze/Iron transition, we can see some interesting continuities with and departures from the kinds of patterns we might expect to accompany the Hittite collapse and its aftermath. Cattle appear to be an important part of the animal economy at Hattuša across multiple excavation areas/periods, as evidenced by the roughly equal representation of caprines and cattle at Karum/Hittite Trans. Kesikkaya Northwest, Hittite Lower Town South Area, and Middle Iron Kesikkaya South (Fig. 5.1b) when species frequencies are calculated by weight. (Hittite Kesikkaya South serves as an exception to this pattern, as discussed above.) However, regardless of method of quantification (i.e. NISP vs. weight vs. DZ), the relative proportion of cattle does not decrease at Middle Iron Age Kesikkaya South relative to the Bronze Age samples, which is a pattern we might expect if it was no longer possible to maintain these large animals due to the economic disruption that accompanied the Hittite collapse. It also suggests the continued importance of cattle across the Bronze/Iron transition, likely for traction, but perhaps also because of their symbolic value.

Of the four samples included here, the Iron Age sample has the lowest proportion of caprines compared to the three Bronze Age samples, again regardless of method of quantification, which, to one degree or another, could point toward a somewhat reduced emphasis on caprine resources. Interestingly, however, the ratio of sheep:goats at Middle Iron Age Kesikkaya South is fairly high, suggesting the possibility of a continued emphasis on wool production long after the Hittite collapse. This ratio is in keeping with what we see at Kesikkaya Northwest during the Hittite/Transitional period.

Again comparing the results to our expectations (Fig. 5.1a), we see low proportions of pigs in the Hittite period samples from Kesikkaya South and Lower Town, South Area (approx.

5-8% when calculated by NISP). This percentage of pigs is higher in the Middle Iron Age sample at Kesikkaya South (%NISP=13.0%), which in turn is similar to the pig signature at Karum/Hittite Transitional Kesikkaya Northwest (%NISP=12.5%). It is worth noting that the Hittite period, which presumably had the highest degree of political and economic centralization, is accompanied by the lowest percentage of pigs, which are often taken as a marker of decentralized production (Zeder 2003).

### 5.2.2 *Çadır Höyük Results*

#### 5.2.2.1 General overview

A summary of the NISP (Number of Identified Specimens) values for the second to early first millennium BC at Çadır Höyük is presented in Table 5.17. The majority of the second to early first millennium animal remains are mammalian, and four domesticated taxa, including sheep (*Ovis aries*), goat (*Capra hircus*), pig (*Sus scrofa*) and cattle (*Bos taurus*), dominate the assemblage. Caprines (N=951) are the most common, followed by cattle (N=470), and pigs (N=259). Equids (including horse [*Equus caballus*] and donkey [*Equus asinus*]) appear in relatively small numbers (N=69) across this long time span, but they become very well represented in the Middle Iron Age. The Middle Iron Age sample also included a single small felid (domestic cat sized) specimen.

ID	Middle Bronze (MB I)	Old Hittite (MB II)	Middle Hittite (LB I)	Hittite Empire/ Trans. (LB II)	Early Iron	Middle Iron	Grand Total
Unidentified	145	371	849	237	878	14	2494
Very small mammal	0	3	5	0	3	4	15
Small mammal	2	7	21	15	10	8	63
Medium mammal	97	178	993	144	602	560	2574
Large mammal	65	193	590	62	232	136	1278
Medium artiodactyl	0	0	13	1	9	26	49
Large artiodactyl	3	26	34	7	17	15	102
<i>Ovis/Capra</i>	20	39	214	23	209	250	755
<i>Ovis aries</i>	1	6	31	1	13	52	104
<i>Capra hircus</i>	4	2	17	3	11	55	92
Medium bovid/cervid	2	5	39	14	34	9	103
<i>Bos taurus</i>	21	43	197	29	74	106	470
Medium cervid	0	0	0	0	0	2	2
Large cervid	0	0	2	0	1	4	7
<i>Sus scrofa</i>	10	30	127	5	17	70	259
Small/medium equid	0	2	4	0	5	10	21
Large equid	0	0	1	0	1	29	31
<i>Equus</i> sp	0	0	4	0	0	13	17
Medium carnivore	0	1	2	0	0	0	3
Small felid	0	0	0	0	0	1	1
<i>Martes foina</i>	0	0	0	0	0	31	31
<i>Mustela nivalis</i>	0	0	0	0	1	2	3
<i>Meles meles</i>	0	1	0	0	0	0	1
Medium canid	73	4	38	0	4	8	127
cf. <i>Canis lupus</i>	0	0	1	0	0	0	1
<i>Vulpes</i> sp.	0	4	3	0	1	5	13
Erinaceid	0	0	0	0	0	1	1
Rodentia	1	16	3	0	11	0	31
<i>Spalax</i> sp.	0	1	0	0	0	0	1
<i>Lepus</i> sp.	1	3	4	0	2	3	13
<i>Testudo</i> sp.	0	3	1	0	1	41	46
Aves	2	3	7	1	4	4	21
	<b>447</b>	<b>941</b>	<b>3200</b>	<b>542</b>	<b>2140</b>	<b>1459</b>	<b>8729</b>

Table. 5.17 Taxonomic identifications in the second to first millennium BC stratigraphic sequence at Çadır Höyük (based on Number of Identified Specimens - NISP).

Likewise, canids (typically dog-sized) are present at Çadır from the second millennium into the first millennium (N=127). The medium canid (dog-sized) specimen count is highest for the Karum period (N=73); however, the majority of these specimens (69 out of 73) belong to what appears to be an articulated neonate. The Bronze Age assemblage at Çadır also contains what is likely a wolf (*Canis lupus*) mandible, dating to the Middle Hittite period (LBI). Based on its tooth measurements, this specimen is within the size range of Near Eastern wolf and is consistent with the size of a modern wolf from Israel (Dayan et al. 2002). Given the very light wear on the first molar, this specimen seems to have belonged to a juvenile animal.

Generally speaking, wild taxa are relatively rare at the site. Among wild mammals, hare (*Lepus capensis*) (N=13) and fox (*Vulpes vulpes*) (N=13) are most abundant followed by very small numbers of deer (*Cervus elaphus*, *Dama dama*; possibly also *Capreolus capreolus*) (N=9) and mustelids (*Mustela nivalis* [N=3] and *Meles meles* [N=1]). A large number of bones (N=31) was also recovered from what appears to have been an articulated stone marten (*Martes foina*) skeleton. Rodents, some of which may have been intrusive, were identified in the assemblages from these periods, as was one hedgehog (Erinaceinae). Regarding non-mammalian animals, tortoises (*Testudo* sp.) and birds (Aves) are present, but other reptiles, as well as amphibians and fish are absent.

#### 5.2.2.2 Species Frequencies by NISP, Weight, and Diagnostic Zone

As with the Hattuşa materials, species frequencies at Çadır were assessed in three ways: number of identified specimens (NISP), weight in grams, and diagnostic zone (DZ) counts (Fig. 5.2).

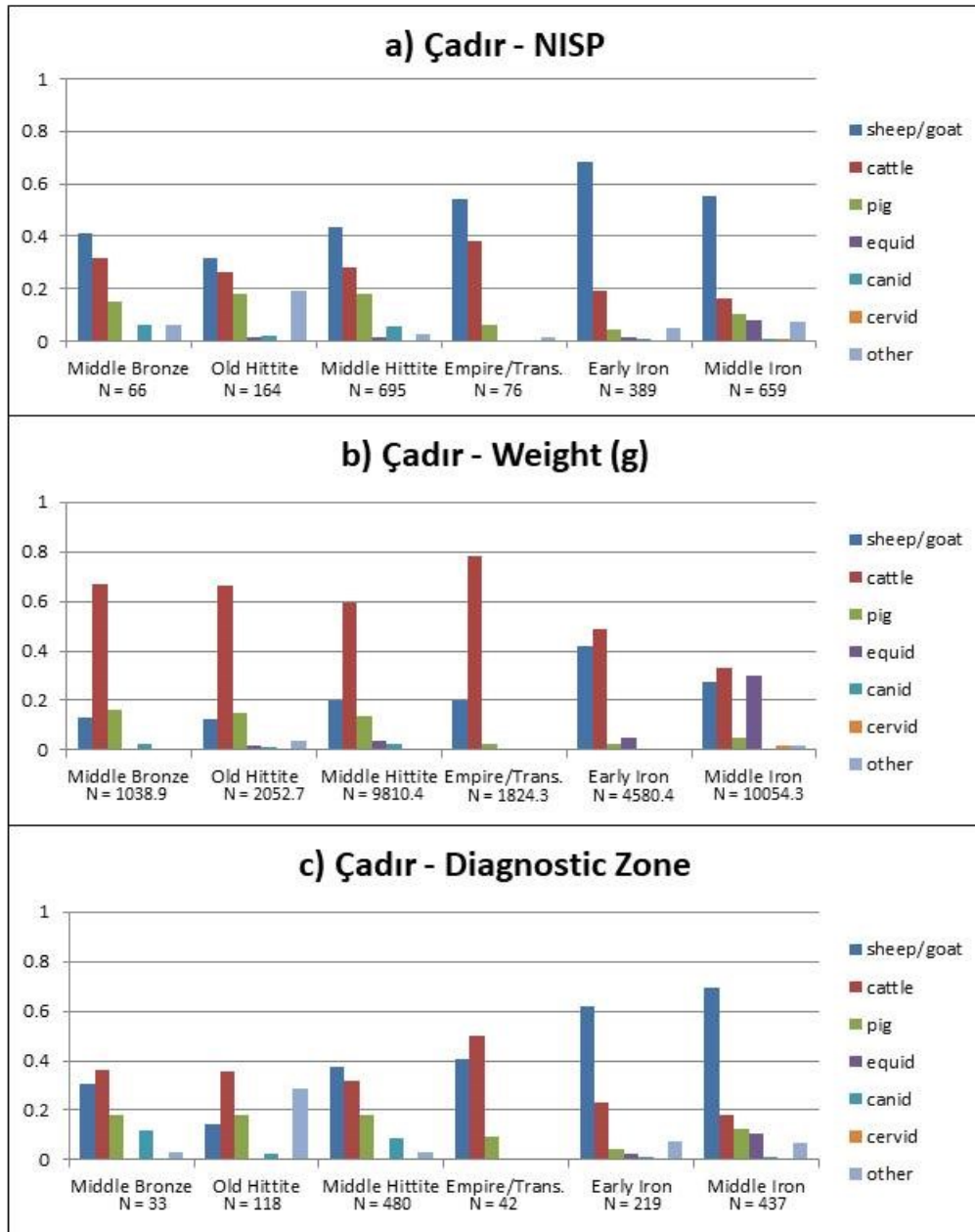


Figure 5.2 Percentage of primary taxa at Çadır Höyük.

### Number of Identified Specimens (NISP)

During the Karum period (MB I) at Çadır, caprines have the highest frequency of all the included taxa when species frequencies are calculated by NISP (%NISP=40.9%) (Fig. 5.2a). They are followed in order of abundance by cattle (%NISP=31.8%), pigs (%NISP=15.5%), canids (%NISP=6.1%), and the “other” category (%NISP=6.1%), which in this case represents hare, rodents, and birds. (The nearly complete neonate dog skeleton mentioned in the overview was given a count of “1” in this calculation so as not to skew the results heavily.) Equids and cervids are absent.

During the Old Hittite period (MB II) at Çadır, caprines dominate the assemblage (%NISP=31.7%), but they are followed closely by cattle (%NISP=26.2%). The “other” category has the next-highest relative representation (%NISP=19.5%). For this period, the “other” category comprises indeterminate medium carnivore, fox, badger, hare, rodent, tortoise, and bird. The rodent count is high relative to overall sample size (rodent NISP=17), which helps contribute to the relatively high representation of “other” taxa. The least represented taxa are canids (%NISP=2.4%) and equids (%NISP=1.8%). Cervids are absent.

During the Middle Hittite (LB I) period at Çadır, caprines are the most common (%NISP=43.3%) taxon, followed by cattle (%NISP=28.3%) and pigs (%NISP=18.3%). Canids are present in smaller numbers (%NISP=5.6%), as are animals in the “other” category (%NISP=2.9%), here representing indeterminate medium carnivore, fox, hare, tortoise, and bird. Equids and cervids are present as well, though not with great abundance (respectively, %NISP=1.3% and 0.3%).

During the Hittite Empire/Transitional (LB II) period at Çadır, caprines are the most abundant animals (%NISP=53.9%), followed by cattle (%NISP=38.2%), and pigs (%NISP=6.6%). A single bird specimen (%NISP=1.3%) comprises the “other” category.

During the Early Iron Age, caprines have the highest representation by far (%NISP=68.6%), followed by cattle (%NISP=19.0%), the “other” category (%NISP=5.1%) (here comprising weasel, fox, hare, rodent, tortoise, and bird), and pigs (%NISP=4.4%). Equids (%NISP=1.5%), canids (%NISP=1.0%), and cervids (0.3%) are also present in very small percentages.

During the Middle Iron Age at Çadır, caprines have the highest representation (%NISP=55.5%), followed by cattle (%NISP=16.1%), and pigs (%NISP=10.6%). Equids are also well-represented (%NISP=8.0%). Animals in the “other” category have the next highest representation (%NISP=7.6%). For this period, the “other” category contains a small felid (domesticated cat-sized), stone marten (N=31; NISP adjusted down to 1 to account for the fact that all of these bones seem to have come from one individual), hedgehog, hare, fox, tortoise, and bird. Also present in small quantities are canids (%NISP=1.2%) and cervids (%NISP=0.9%).

### Weight (g)

When the Karum period (MB I) materials at Çadır are analyzed by weight (Fig. 5.2b), cattle are the most abundant taxon (%weight=67.1%) followed by pigs (%weight=16.5%) and caprines (%weight=13.0%). Canids have the next greatest abundance (%weight=2.6%). The relative representation of the taxa in the “other” category is quite small (%weight=0.8%). Equids and canids are absent.

Cattle (%weight=66.1%) dominate the Old Hittite (MB II) assemblage at Çadır when the materials are analyzed by weight. They are followed by pigs (%weight=14.8%) and caprines (%weight=12.5%). The “other” category has the next highest representation by weight (%weight=3.4%), followed by equids (%weight=1.9%), and canids (%weight=1.3%). Cervids are absent.

During the Middle Hittite (LB I) period, cattle (%weight=59.7%) have the highest relative representation by weight at Çadır, followed by caprines (%weight=20.1%), and pigs (13.5%). The relative proportions of the other taxonomic categories are much lower. Equids have a relative representation of 4.0% by weight, followed by canids (%weight=2.2%), the “other” category (%weight=0.3%), and cervids (%weight=0.1%).

During the Hittite Empire/Transitional (LB II) period, cattle (%weight=78.0%) have the highest relative representation by weight at Çadır, followed by caprines (%weight=19.8%). Pigs are poorly represented (%weight=2.1%), and the other category is represented by a small fraction of a percent. All other taxa are absent.

During the Early Iron Age at Çadır, cattle (%weight=49.1) have the greatest abundance by weight, followed closely by caprines (%weight=41.7%). Equids (%weight=4.9%) are the third most abundant taxon, followed by pigs (%weight=2.8%) and distantly by canids (%weight=0.8%), cervids (%weight=0.7%), and the “other” category (%weight=0.1%).

During the Middle Iron Age at Çadır, cattle are the most abundant taxon by weight (%weight=33.2%), followed closely by equids (%weight=30.2%), and caprines (%weight=27.4%). These animals are followed in relative representation by pigs (%weight=5.1%), cervids (%weight=1.9%), the “other” category (%weight=1.7%), and canids (%weight=0.5%).

### Diagnostic Zone (DZ)

During the Karum period (MB I) at Çadır, cattle (%DZ=36.4%) have the highest representation when species frequencies are calculated using diagnostic zones (Fig. 5.2c). They are followed closely by caprines (%DZ=30.3%). Pigs have the next highest representation (%DZ=18.2), followed by canids (%DZ=12.1%) and the “other” category (%DZ=3.0%). The largely complete neonate dog skeleton present in this sample was adjusted down to a diagnostic zone count of 2 in order to avoid skewing the results toward that category.

During the Old Hittite period (MB II) at Çadır, cattle have the highest representation of any taxon in the sample (%DZ=35.6%). They are followed by the “other” category (%DZ=28.8%), by pigs (%DZ=17.8%), and by caprines (%DZ=14.4%). Canids have the next highest relative representation (%DZ=2.5%), followed by equids (%DZ=0.8%). Cervids are absent.

During the Middle Hittite period (LB I) at Çadır, caprines (%DZ=37.5%) have the highest relative representation when species frequencies are calculated by diagnostic zone. They are followed by cattle (%DZ=31.7%), pigs (%DZ=18.1%), and canids (%DZ=8.8%). Present in lower frequencies are animals in the “other” category (%DZ=3.1%) and equids (%DZ=0.8%). Cervids are absent.

During the Hittite Empire/Transitional (LB II) period at Çadır, cattle (%DZ=50.0%) are the most abundant taxon when species frequencies are calculated by diagnostic zone. They are followed in order of frequency by caprines (%DZ=40.5%), and pigs (%DZ=9.5%).

During the Early Iron Age at Çadır, caprines (%DZ=62.1%) are the most abundant taxon when species frequencies are calculated by diagnostic zone. They are followed by cattle

(%DZ=22.8%), the “other” category (%DZ=7.8%), pigs (%DZ=4.1%), equids (%DZ=2.3%), and canids (%DZ=1.4%). Cervids are absent.

During the Middle Iron Age at Çadır, caprines (%DZ=69.6%) are the most abundant taxon when species frequencies are calculated by diagnostic zone. They are followed in order of frequency by cattle (%DZ=17.8%), pigs (%DZ=12.6%), equids (%DZ=10.3%), the “other” category (%DZ=6.6%), canids (%DZ=0.9%), and cervids (%DZ=0.7%).

### 5.2.2.3 Discussion of Çadır Species Frequencies

Notably, when calculated by NISP (Fig. 5.2a), the relative proportion of caprines at Çadır grows steadily over time from the mid-second into the early first millennium BC. Caprine frequencies are lowest in the Old Hittite (MB II) period (32%), which is a notably low frequency given the time and place. Caprine frequencies peak at the site in the Early Iron (69%) before dropping somewhat in the Middle Iron Age (56%). Earlier in the second millennium, during the Karum (MB I) period, caprine frequencies are similar to those of the Middle Hittite (LB I) period (both around 40%).

The growth in caprines across the Hittite periods is accompanied by a decreased proportion of cattle moving into the Iron Age. Throughout the second millennium (Karum period through Hittite Empire/Trans.), the representation of cattle and caprines remains relatively similar (approx. 10% difference during the Karum period; approx. 6% difference during the Old Hittite period; approx. 15% difference during the Middle Hittite period; approx. 16% difference during the Hittite Empire/Transitional period). However, during the Early Iron Age, the proportion of cattle drops precipitously, and there are over three times as many caprines as cattle

(caprine NISP%=68.6%; cattle NISP%=19.0%). This relative proportion remains consistent in the Middle Iron Age at the site (caprine NISP%=55.5%; cattle NISP%=16.1%).

Similarly, the proportion of pigs decreases at the site around the time of the Hittite collapse. While the relative proportion of pigs remains steady from the Karum period (MB I) through the Middle Hittite (LB I) period (NISP% ranging from 15% to 19%), this percentage drops in the Hittite Empire/Transitional period (NISP%=6.6%) and reaches its lowest percentage in the Early Iron Age (NISP%=4.4%). After this, the proportion of pigs increases somewhat moving into the Middle Iron Age (NISP%=10.6%).

Also worth noting is that the Middle Iron Age assemblage also contains a much higher than usual proportion of equid remains than the other periods. Generally, equids make up between 0 and 2% of the second and first millennium Çadır samples. During the Middle Iron Age, however, they comprise 8.0% of the overall sample. Canids (the vast majority of which are dog-sized), on the other hand, are best represented in the Bronze Age periods<sup>3</sup>. During the Karum, Old Hittite, and Middle Hittite periods, canids make up 6.1%, 2.4%, and 5.6% of the assemblages respectively. However, during the Early and Middle Iron Ages, they comprise only 1.0% and 1.2% of the respective assemblages. Cervids have the greatest abundance during the Middle Iron Age, but even in that case, their relative representation is less than 1%.

Of the six periods included in this study, the Hittite Empire/Transitional phase has the lowest species diversity; aside from a single bird bone, all of the specimens from this context were identified as sheep, goat, pig, or cattle. In contrast, for example, the Old Hittite phase has twelve identified taxa, and the Hittite Empire and Early Iron Age phases have thirteen. The

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<sup>3</sup> Note that the “Other” category for the Old Hittite period at Çadır appears to be quite high when calculated by NISP and DZ due to a higher than usual number of rodent bones in this sample.

limited range of taxa in the Hittite Empire/Transitional sample could be a factor of its small size, but it might also be tied to the function of the industrial context in which these specimens were excavated (see Chapter 2).

Several of these general trends are echoed when the species frequencies are calculated by weight (Fig. 5.2b). As is the case for the Çadır species frequencies when calculated by NISP, the proportion of caprines increases over time when calculated by weight, and its frequency peaks in the Early Iron Age. There is also a concurrent decrease in the proportion of cattle during the Early Iron Age, following the Hittite collapse. Likewise, the proportion of pigs drops during the Hittite Empire/Transitional phase and into the Iron Age relative to the Karum (MB I) through Middle Hittite (LB I) periods. However, there are some notable departures from the NISP frequencies.

First, the weight results underscore the importance of cattle in the animal economy at Çadır. When examined by bone weight, a proxy for meat contribution, cattle clearly dominate the Çadır animal bone assemblage prior to the Hittite collapse. During the Hittite period, cattle percentages 66.1% during the Old Hittite, to 59.7% during the Middle Hittite period, to 78.0% during the Hittite Empire/Transitional period. Even in the Early Iron Age they are well-represented at over 49.1%, half of the assemblage by weight. At the same time, it's important to remember that this quantitative approach does not take secondary products into account: since the focus is on meat weight, the relative importance of other products such as dairy, fiber, and traction is elided.

Second, examining relative species frequencies by weight highlights differences in species distributions between the Middle Iron Age and the other five samples, with the representation of cattle (%weight=33.2%), equids (%weight=30.2%), and caprines

(%weight=27.4%) being nearly evenly distributed in this period. As was noted above with regard to species frequencies calculated using NISP, this percentage of equids is especially high.

Calculating the species frequencies using diagnostic zones (Fig. 5.2c) highlights the increase in caprines from the second millennium onward, which is also reflected in the NISP distribution. In this case, the relative proportion of caprines is unusually low during the Old Hittite period (%DZ=14.4%) and gradually increases over the following millennium, peaking in the Middle Iron Age (%DZ=69.6%). When species frequencies are calculated using diagnostic zones, cattle experience the same drop in frequency moving from the Bronze into the Iron Age as with NISP and weight. Likewise, the proportion of pigs once again drops during the Hittite Empire/Transitional period and stays low during the Iron Age.

#### 5.2.2.4 Çadır Sheep to Goat Ratios

When the ratios of sheep to goats were calculated for Çadır, the materials from the Karum, Old Hittite, and Hittite Empire/Transitional periods were excluded due to sample size. The sheep to goat ratios spanning the Bronze-Iron Age transition at Çadır can be seen in Table 5.18. In the Middle Hittite phase, sheep outnumber goats by 1.8:1 (Table 5.18), suggesting there may have been some emphasis on wool production at Çadır during the Hittite period.

	<b>Middle Hittite</b>	<b>Early Iron</b>	<b>Middle Iron</b>
<b>sheep</b>	31	13	52
<b>goat</b>	17	11	55
<b>sheep:goat</b>	1.82	1.18	0.95

Table 5.18 Comparison of sheep to goat ratios at Çadır Höyük over time

In the Early Iron Age, however, the ratio shifts such that sheep and goats become much more evenly represented (1.2:1), which sheep outnumbering goats, but only slightly. This downward trend continues in the Middle Iron Age where goats very slightly outnumber sheep (sheep to goat ratio = .95:1). This change suggests that at least some aspects of sheep and goat husbandry changed at Çadır after the Hittite collapse. In particular, the decreased emphasis on sheep husbandry during the Iron Age points toward a growing emphasis on herd security and low-risk production strategies where the commodity production of wool was no longer an aim.

#### 5.2.2.5 Çadır Höyük Summary

Analysis of the faunal remains from Çadır Höyük reveals several notable aspects. First, there is an increasing emphasis on caprine production at the site that begins during the Old Hittite period (starting around 1680 BC.) and continues well into the first millennium BC, spanning the “divide” between the Late Bronze and Iron Ages. When calculated by NISP, this gradual increase in the percentage of caprines peaks in the Early Iron Age; when calculated by diagnostic zone, this growth continues in the Middle Iron Age (Fig. 5.2). This increase in caprines continues unabated at the site following the collapse of the Hittite empire around 1200 BC.

However, even as caprine management at Çadır seems to become more important across this span of time, this growing emphasis also coincides with an apparent shift in how these animals are managed. While the overall proportion of caprines continues to grow, we see a gradual decrease in the ratio of sheep to goats at the site over time (Table 5.18). In the Early Iron Age, the representation of sheep to goats is around 1.2:1, a decrease from nearly 2:1 in the

Middle Hittite period. And in the Middle Iron Age, goats (associated with conservative herding strategies and herd security [Redding 1984]) come to outnumber sheep.

Second, cattle make a surprisingly high contribution to the animal economy at Çadır during the Bronze Age. The mean cattle value for Çadır during the Hittite period (averaging the %NISP for Old Hittite, Middle Hittite, and Hittite Empire/Transitional periods) is 31%. The importance of cattle at Çadır during the Bronze Age is further highlighted when the site's species frequencies are calculated by weight (Fig. 5.2b). Cattle are often associated with wealth and “value” as well as agricultural labor in the ancient world (Arbuckle 2014), so it may seem surprising to find such higher proportions of cattle at a rural center, particularly given Indo-European associations between cattle and wealth/prestige (Anthony 2007). However, the high incidence of cattle at Çadır during the Bronze Age would fit in well with interpretations that have identified the site as a Hittite cultic center (Gorny 2005, 1997; cf. Popko 2000), visited regularly by the Hittite king and his officials. The fact that cattle proportions at the site drop off in the Iron Age is certainly suggestive of shifting priorities, especially given the amount of resources that must be expended to maintain cattle (Arbuckle 2014). Similarly, it may suggest that intensive agriculture, in which cattle play a key part (Miller et al. 2009), was an aspect of life at Çadır during the Hittite period, and that this changed in the Iron Age as the percentage of cattle decreased and caprine production intensified.

Finally, it's worth noting that there is a marked decrease in pig frequencies at Çadır during the Early and Middle Iron Age when compared to those of the preceding Bronze Age period. This pattern goes against expectations that pig percentages might increase at Çadır after the Hittite collapse.

### 5.2.3 Species Frequencies: Hattuşa vs. Çadır Höyük, Summary and Comparison

During the Hittite period at Çadır cattle percentages are notably higher than they are at Hattuşa, a difference that becomes especially marked when species frequencies are examined by weight (Figs. 5.1b and 5.2b). At Hattuşa, when the Middle Iron assemblage at Kesikkaya South is compared to the Bronze Age assemblages at Kesikkaya Northwest, Kesikkaya South, and the Lower Town, South Area, cattle percentages remain fairly similar across the Bronze/Iron transition. At Çadır, however, cattle percentages decrease considerably moving into the Iron Age. It seems probable that the high percentages of cattle at Çadır during the Old Hittite, Middle Hittite, and Hittite Empire/Transitional periods may relate to intensive agriculture (i.e. the use of cattle for traction), as well as perhaps a symbolic role if Çadır did indeed serve as a cultic center. The lower percentage of cattle at Hattuşa across both Bronze and Iron Age samples suggests that agricultural activity around the site may not have been as intensive (or at least, was not being reflected in these excavation areas). Given the large-scale grain storage present at the site during the Hittite period (Seeher 2002; Schachner 2011), it may well have been the case that rural sites like Çadır were more intensively engaged in agricultural production and were sending surplus to Hattuşa.

As noted above, the proportion of caprines decreases somewhat in the Middle Iron Age at Kesikkaya South in comparison to the Hittite period samples from Kesikkaya South and Lower Town South Area, but the sheep to goat ratio is high in the Middle Iron Age (3:1). At Çadır, on the other hand, the increase in caprine frequencies that was occurring across much of the second millennium at the site continued unabated into the Early Iron Age, following the Hittite collapse. At the same time, however, sheep to goat ratios decreased, resulting in a growing representation of goats in the Iron Age (approx. 1:1). Generally speaking, what is especially notable when

comparisons are made between the two sites is the fact that overall, the sheep to goat ratios at Çadır are much lower than those at Hattuşa. Given the differences in scale and political prominence between these two sites, this difference most likely points toward different production goals between the producers at Hattuşa vs. Çadır. In both cases, we see a possible emphasis on wool production (or at least sheep and their products) during the Bronze Age and, following the Hittite collapse at Çadır, a movement towards less risky, more diversified production strategies.

### **5.3 Survivorship and Mortality**

#### *5.3.1 Caprine Survivorship/Mortality Results*

##### 5.3.1.1 Hattuşa Caprine Aging Results

###### *Hattuşa Caprine Aging Based on Mandibular Wear Stages*

Caprine survivorship and mortality results for the Karum/Hittite Transitional period at Kesikkaya Northwest, the Hittite period at Lower Town, South Area, and the Middle Iron Age at Kesikkaya South appear in Fig. 5.3. Data from other site areas/periods have been excluded due to small sample sizes.

During the Karum/Hittite Transitional period at Kesikkaya Northwest, kill-off of caprines is minimal until the animals reach six to twelve months of age; at this point, survivorship drops to around 87% (Fig. 5.3a). During this period, the mode mortality occurs between the ages of three and six years (Payne's [1973] wear stages F and G) (Fig. 5.3b). The mortality rate during this time is almost 50%.

During the Hittite period at Lower Town, South Area, kill-off doesn't begin to intensify until the animals reach one to two years of age. At this point, survivorship drops to around 84%

(Fig. 5.3a). The mortality distribution is bi-modal, with a large peak in mortality at two to three years (Payne's wear stage E) (Fig. 5.3c). This pattern is represented as a relatively steep drop in the survivorship profile (Fig. 5.3a). Another smaller peak in mortality occurs between the ages of four and six years (Payne's wear stage G).

Within the Middle Iron Age assemblage at Kesikkaya South, caprine kill-off begins to intensify between one to two years of age. At this point, survivorship drops to around 82% (Fig. 5.3a). Kill-off peaks between three and four years of age (Payne's wear stage F), with a mortality rate of around 29% for this stage (Fig. 5.3d).

The caprine mortality histograms (Fig. 5.3bcd) for these assemblages display several notable aspects. In all three cases, very young animals (those younger than six months old) are largely or completely absent. This pattern may relate to taphonomy, but it may also relate to provisioning or production strategies.

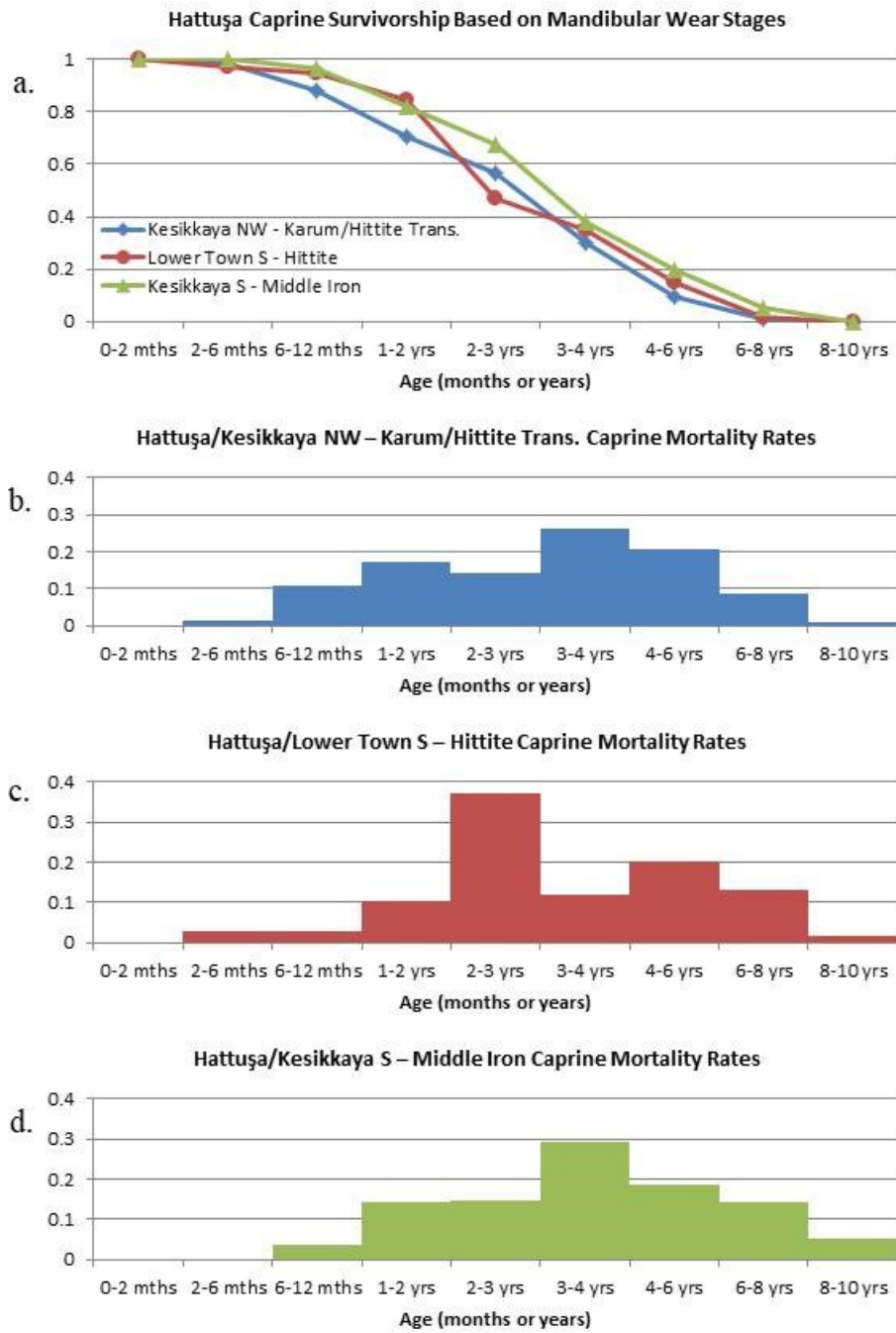


Figure 5.3. Hattuša caprine survivorship and mortality rates based on mandibular wear stages.

Interestingly, in the case of the Lower Town, South Area, Hittite distribution (Fig. 5.3c), a large proportion of animals was killed between the ages of two and three years (Payne's wear stage E), the time at which caprines reach prime meat weight (Stein 1987). This pattern could represent a provisioning strategy, where this area of the site was being provisioned with prime meat weight animals during the Hittite period. This interpretation may also be supported by the near complete absence of animals younger than one year in this sample. The absence of very young animals could relate to taphonomy, but it may also suggest that caprines were being raised elsewhere and brought into the Lower Town for consumption. A second, smaller peak in kill-off occurs in the Hittite mortality histogram between the ages of four to six years, a later kill-off potentially relating to secondary products production.

Results for the Karum period (Kesikkaya Northwest) and Middle Iron Age (Kesikkaya South) appear quite different. In both of these cases, kill-off doesn't peak until the age of three to four years (Fig. 5.3bd), and survivorship also doesn't drop to less than 50% until this point (Fig. 5.3a). This later kill-off may suggest a production strategy with an emphasis on fiber production in these periods. In any case, however, the distributions are suggestive of fairly similar production strategies at Karum period Kesikkaya Northwest and Middle Iron Age Kesikkaya South, which differ from how animals were being managed at Hittite Lower Town South.

#### *Hattuša Caprine Aging Based on Epiphyseal Fusion*

Based on epiphyseal fusion, at Karum/Hittite Transitional period Kesikkaya Northwest (Fig. 5.4a), most caprines (approx. 95%) survive the juvenile stage (Stage I) based on epiphyseal fusion. Around 82% survive the young adult stage (Stage II). Survivorship drops considerably by the adult phase (Stage III), down to approximately 49%.

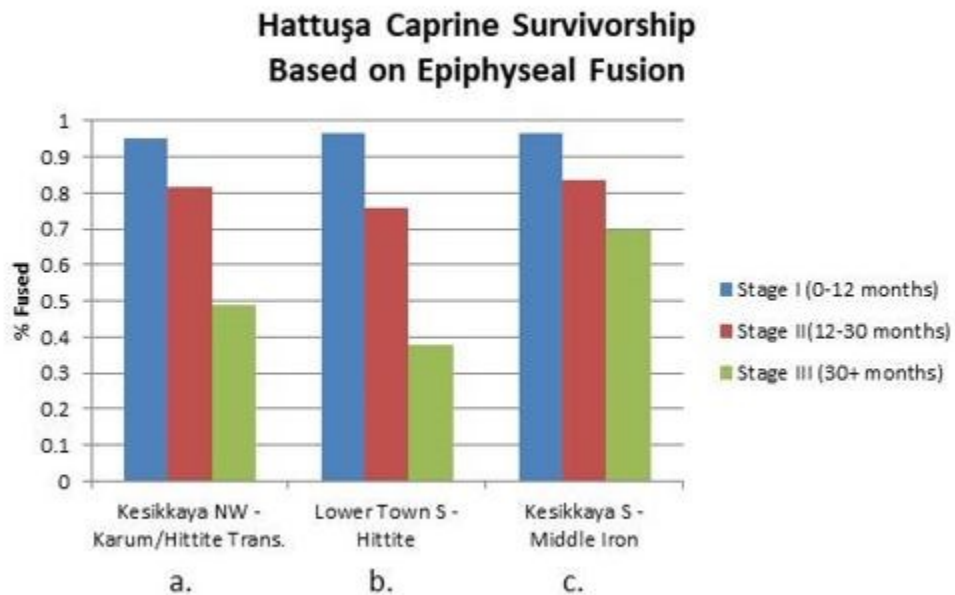


Figure 5.4 Hattuša caprine survivorship based on epiphyseal fusion.

At Hittite period Lower Town, South Area (Fig. 5.4b), the vast majority of caprines (approx. 97%) survives the juvenile stage (Stage I). Survivorship drops by around 20% (down to 76% during the young adult stage (Stage II). After this, survivorship drops considerably in the adult stage (Stage III), down to approximately 38%.

At Middle Iron Age Kesikkaya South (Fig. 5.4c), survivorship is high (approx. 97%) during the juvenile stage (Stage I). Around 83% of caprines survive the young adult stage (Stage II). Survivorship during the adult stage is fairly high, around 70%.

Among these three Hattuša assemblages, caprine survivorship patterns appear to be the most similar between the Karum/Hittite Transitional period sample from Kesikkaya Northwest (Fig. 5.4a) and the Hittite period sample from Lower Town, South Area (Fig. 5.4b). In both

cases, caprine survivorship is very high in the juvenile stage (Stage I), ranging from 95 to 97%. During the young adult stage (Stage II), there is a drop in survivorship (approx. 13% at Kesikkaya Northwest and 21% at Lower Town, South Area). This is followed by a much larger drop in survivorship between the young adult stage and the adult stage (Stage III) (approx. 33% at Kesikkaya Northwest and 38% at Lower Town, South Area). In essence, this pattern points toward the kill-off of a majority of caprines in these samples before they reach 30 months of age.

The pattern at Middle Iron Age Kesikkaya South (Fig. 5.4c) is noticeably different, particularly with regard to the adult stage (Stage III). While in the Kesikkaya Northwest and Lower Town, South Area samples, caprine survivorship drops by a large amount (33 to 38%) in the adult stage, in the Middle Iron Kesikkaya South sample, survivorship only decreases by 14% in this sample, suggesting that animals in this sample were being kept alive longer into adulthood.

### 5.3.1.2 Çadır Höyük Caprine Aging Results

#### Çadır Höyük Caprine Aging Based on Mandibular Wear Stages

Caprine survivorship and mortality results for Hittite period (combining the Old Hittite, Middle Hittite, and Hittite Empire/Transitional materials), Early Iron Age, and Middle Iron Age at Çadır are presented in Fig. 5.5. Data from the Karum period (MB I) were excluded due to sample size.

During the Hittite period at Çadır (Fig. 5.5ab), very few caprines younger than six months of age appear. The majority of kill-off occurred between the ages of two and six years, with the mode falling at three to four years (Payne's wear stage F). After this point, survivorship

declines sharply, with only around five percent of the sample surviving to reach six to eight years (Payne's wear stage H).

During the Early Iron Age (Fig. 5.5ac), more young animals (aged 2-6 months; Payne's wear stage B) are present. These data are bimodal at one to two years (Payne's wear stage D) and three to four years (Payne's wear stage F), but these peaks are small, and the overall distribution is fairly even over time (Fig. 5.5c). The gradual consumption of animals in all age groups is also visible in the survivorship profile for the period (Fig. 5.5a), which has a very gently sloping downward trajectory.

No caprines younger than six to twelve months appear in the Middle Iron Age sample at Çadır. This mortality distribution (Fig. 5.5d) is very clearly bi-modal, with one cluster around six months to two years of age (Payne's wear stages C and D) and another between three and eight years (Payne's wear stages F, G, and H).

These results show that during the Hittite period at Çadır (Fig. 5.5b), the majority of animals were being kept well into adulthood and were killed after prime meat weight had been reached, which occurs around two to three years (Stein 1987). Given that animals exploited for wool production (particularly males) tend to be kept alive much later into adulthood (Payne 1973), the late kill-off of sheep and goats in the Hittite period may be representative of fiber production, supported by the higher ratio of sheep in the Middle Hittite phase, which would fit with a model of a commodity-oriented regional economy/stability brought by the Hittites. The low representation of juveniles may also reflect a provisioning strategy for the Hittite settlement at Çadır. However, the shape of the Hittite phase mortality histogram might also indicate a conservative herding strategy where animals were kept alive past prime meat weight in order to minimize risk.

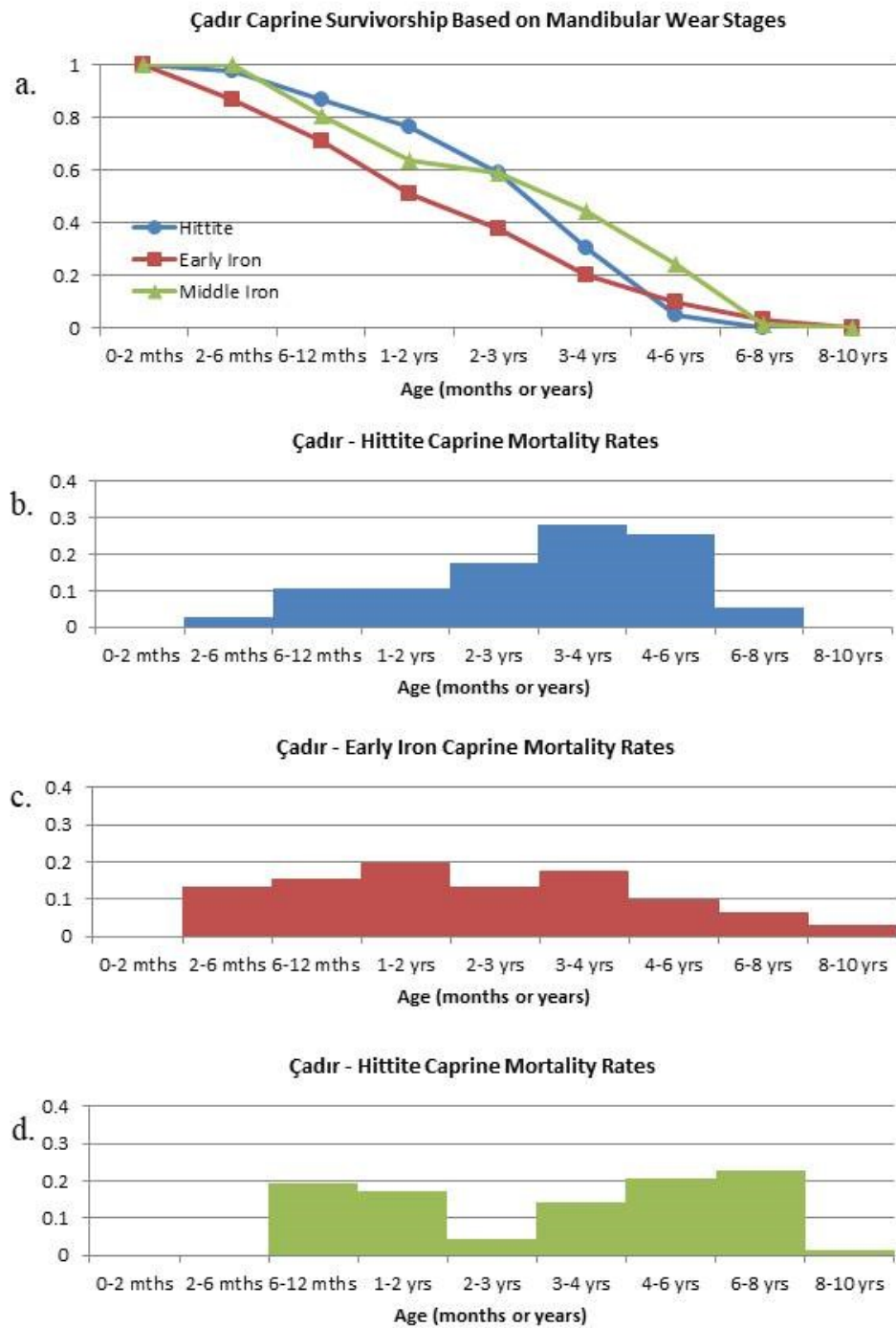


Figure. 5.5. Çadır Höyük caprine survivorship and mortality rates based on mandibular wear stages.

On the other hand, in the Early Iron Age (Figure 5.5c), the gradual consumption of the caprines in the assemblage, visible in the relatively even distribution of age categories, is suggestive of a multi-use/generalized herding strategy in which animals are used for both primary (meat, skins) and secondary (milk, fiber) products and production is not intensive. Along with the growing frequency of goats relative to sheep in the Iron Age, this pattern suggests more local production and risk reduction.

The bimodal distribution in the Middle Iron Age (Fig. 5.5d) is noticeably different from what appears in the other samples. Depending on the sex distribution of these animals (discussed below in biometrics section, the first peak could represent the off-take of young males, while the second could represent older females who are done reproducing. This strategy could represent an emphasis on secondary product production, specifically dairy. However, it seems more likely that the complete absence of animals under six months and the near absence of prime meat weight animals is indicative that, during the Middle Iron Age, caprines raised at Çadır were being sent elsewhere, possibly provisioning the nearby Iron Age settlement at Kerkenes Dağ.

#### Çadır Höyük Caprine Aging Based on Epiphyseal Fusion

Based on epiphyseal fusion, at Hittite period Çadır (Fig. 5.6a), most caprines survive the juvenile stage (Stage I) based on epiphyseal fusion. Around 77% survive the young adult stage (Stage II). Survivorship remains fairly high in the adult stage (stage III), around 60%.

During the Early Iron Age at Çadır (Fig. 5.6b), no unfused juvenile (Stage I) caprine specimens were identified, suggesting that survivorship during this stage was very high during the Early Iron Age (Stage I survivorship=100%). Survivorship drops in the young adult stage

(Stage II), down to approx. 75%. During the adult stage, survivorship drops precipitously, down to approximately 10%.

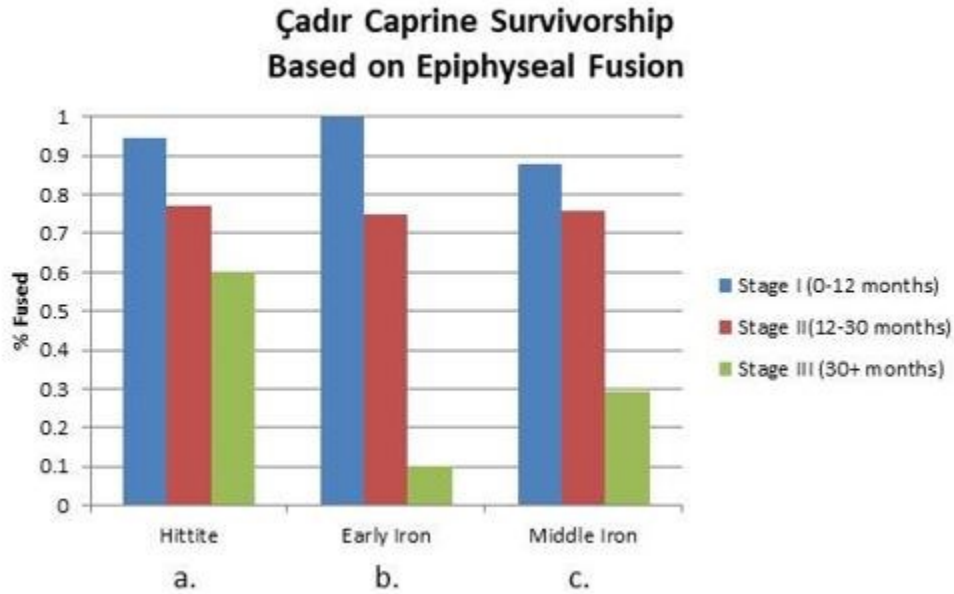


Figure 5.6. Çadır Höyük caprine survivorship based on epiphyseal fusion.

During the Middle Iron Age at Çadır (Fig. 5.6c), juvenile (Stage I) survivorship is lower than average, around 88%. During the young adult stage, survivorship drops by just over ten percent, down to 76%. In the adult stage (Stage III), survivorship drops considerably, down to approximately 30%.

In summary, at Çadır, caprine survivorship appears during the Bronze and Early/Middle Iron Ages appears to be fairly high in the juvenile and young adult phases when examined using epiphyseal fusion rates. Between the ages of 0 and 30 months (Stages I and II), survivorship is no lower than 75% for any period. However, there is a much higher diachronic variation in adult survivorship. In the Hittite period, most caprines (60%) are kept into adulthood (Stage III). This pattern is in strong contrast to the Early Iron Age, when only 10% of caprines survive the age of 30 months. By the Middle Iron Age, adult survivorship has increased to approximately 30%.

### 5.3.1.3 Hattuša vs. Çadır Caprine Aging Comparison

As noted above, the late peak in caprine kill-off (3-4 years, Payne wear stage F) at Kesikkaya Northwest (Karum/Transitional Period) and Kesikkaya South (Middle Iron) may be suggestive of a production strategy focused on intensive fiber production in these periods/locations (Fig. 5.3bd). Conversely, it may also be the result of a provisioning strategy where the urban residents are provisioned with older animals once used for secondary product production (wool, dairy) elsewhere. The Hittite period caprine assemblage from Lower Town, South Area (Fig. 5.3c), is dominated by prime meat weight animals, which does seem suggestive of provisioning.

At Çadır Höyük, the late kill-off of caprines in the Hittite period mortality distribution (Fig. 5.5b), which doesn't peak until three to four years, may be indicative of delayed kill-off related to intensified fiber production, reflecting the presence of a commodity-oriented economy during the Hittite period. Notably, its mortality distribution appears quite similar to two of those at Hattuša, the Karum/Transitional distribution at Kesikkaya Northwest and the Middle Iron distribution at Kesikkaya South (Fig. 5.3bd). However, the late-kill off at Çadır during this time may also reflect a conservative herding strategy, where animals are kept well into adulthood to reduce risk.

Following the Hittite collapse, we see an apparent shift toward a more generalized production strategy and risk reduction, a likely response to economic destabilization in the region following the Hittite collapse. Moving into the Middle Iron Age, as local polities begin to grow and gain power, we see a pattern that suggests that Çadır may have been sending young lambs and prime meat weight animals elsewhere, potentially having been incorporated into a regional provisioning system.

### 5.3.2 Cattle Survivorship/Mortality Results

#### 5.3.2.1 Hattuša Cattle Aging Results

##### Hattuša Cattle Aging Based on Epiphyseal Fusion

Cattle survivorship results for Hattuša based on epiphyseal fusion are presented in Fig. 5.7. These results include materials from the Karum/Hittite Transitional period at Kesikkaya Northwest, the Hittite period at Lower Town, South Area, and from the Middle Iron Age at Kesikkaya South. At Karum/Transitional Period Kesikkaya Northwest (Fig. 5.7a), around 90% of animals survive beyond the young adult stage (Stage II) based on epiphyseal fusion. After this point, survivorship falls off somewhat, down to approximately 55% in the adult stage (Stage III). Survivorship during the Hittite period at Lower Town, South Area (Fig. 5.7b) is generally high across all three age stages, never dropping below 75%. Survivorship during the Middle Iron Age at Kesikkaya South (Fig. 5.7c) is especially high, dropping slightly from 100% in the juvenile stage (Stage I) to 89% in the adult stage (Stage III).

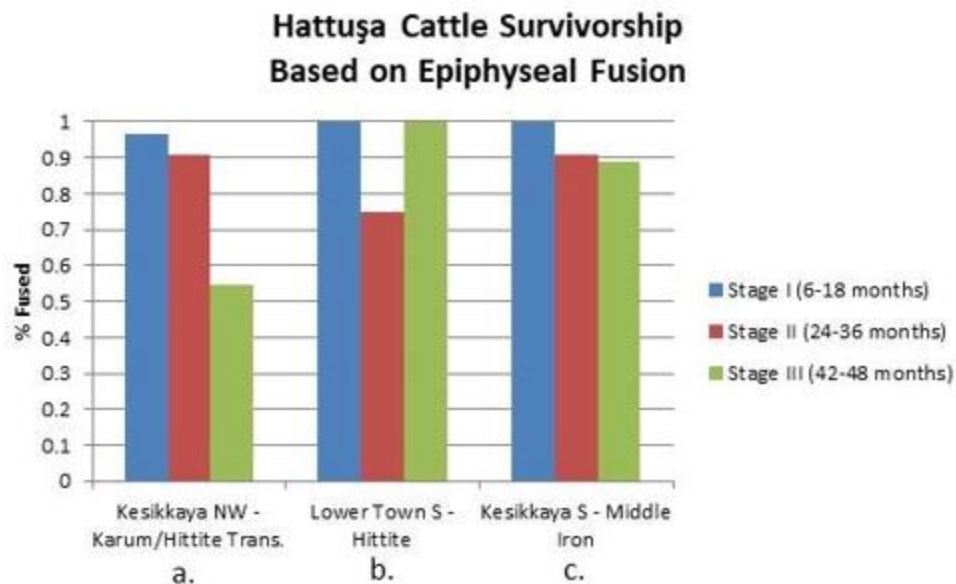


Figure 5.7. Hattuša cattle survivorship based on epiphyseal fusion

### Çadır Höyük Cattle Aging Based on Epiphyseal Fusion

Cattle survivorship results for Çadır Höyük based on epiphyseal fusion are presented in Fig. 5.8. Materials from the Karum period (MB I) were excluded due to sample size. At Çadır Höyük, during the Hittite period (Fig. 5.8a), cattle survivorship during the juvenile stage (Stage I) is approximately 91%, dropping to approximately 67% in the young adult stage (Stage II), and to approximately 43% during the adult stage (Stage III). During the Early Iron Age (Fig. 5.8b), cattle survivorship is very high (100%) during the juvenile and adult stages. It drops in the adult stage, but the sample size for this stage is very small (n=2). During the Middle Iron Age (Fig. 5.8c), cattle survivorship is initially high (averaging to around 90% across Stages I and II). Survivorship somewhat in the adult stage (Stage III), down to 60%.

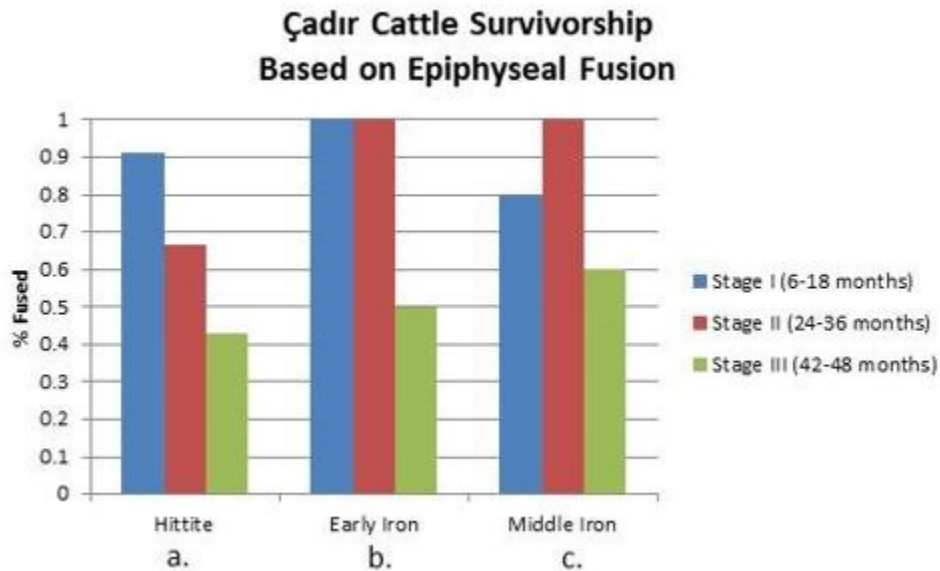


Figure 5.8. Çadır Höyük cattle survivorship based on epiphyseal fusion.

### 5.3.2.2 Hattuša and Çadır Cattle Aging Comparison

Generally speaking, the cattle individuals represented in the samples from Hattuša and Çadır tend to survive well into adulthood. This is in keeping with the patterns one tends to expect in agro-pastoral economies, where adult cattle (particularly male castrates) are used for traction. Having said this, the results suggest that cattle at Çadır tended to be killed off at a slightly younger age, particularly in the Hittite period (Fig. 5.8a), when Stage II (24-36 months) survivorship is less than 70%, and Stage III (42-48 months) survivorship is less than 50%. This suggests that during the Hittite period at Çadır, there may have been a market for cattle meat.

Alternatively, the high proportions of adult cattle at Hattuša may be suggestive of a provisioning system, where this large urban center was being provisioned with adult animals for traction and/or meat. The appearance of more young individuals at Çadır could indicate that this is where cattle were being raised, and the reduced amount of adult individuals at the site could indicate that adult animals were being sent to market elsewhere.

## **5.4 Biometrics**

### *5.4.1 Sheep Biometrics*

#### 5.4.1.1 Hattuša Results

The sheep LSI distribution for the Karum/Hittite Transitional period sample at Hattuša Kesikkaya Northwest (Fig. 5.9a) skews heavily to the right, well above the size of the standard animal. The mode for the distribution appears between around 0.04 and 0.06. The mean LSI value for this sample is .023256 (Table 5.19). Given the fact that sexual dimorphism in sheep is not extremely pronounced, and the very large size of the animals on the right side of the

distribution (larger than a wild female sheep), this continuous distribution likely represents older, large males to the right, with a lesser number of smaller females trailing off to the left.

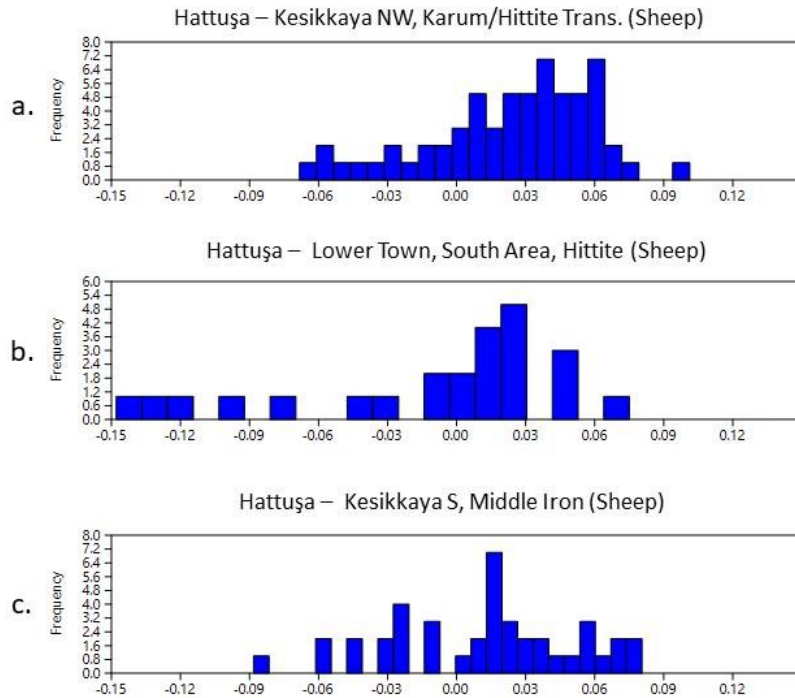


Figure 5.9. Logarithmic size index (LSI) distributions for Hattuša sheep.

The distribution for the Hittite period at the Lower Town, South Area (Fig. 5.9b) also skews heavily to the right, above the size of the standard animal. The distribution is unimodal, with the mode of the distribution occurring at 0.03. The mean LSI value is -0.0109 (Table 5.19). The shape of the distribution is likely suggestive of a large number of larger adult male animals

to the right on the right end of the distribution, and a smaller number of adult female animals (and possibly subadults) extending off to the left.

The Middle Iron distribution from Kesikkaya South (Fig. 5.9c) also skews to the right, with a majority of the samples falling above the size of the standard animal. This distribution has multiple modes. The largest falls around 0.015, part of a cluster above the size of the standard animal that likely represents male animals. The second highest mode, which falls around -.025, likely represents smaller females. The mean LSI value for the Middle Iron Kesikkaya South sample is 0.011772 (Table 5.19).

Site	Period	Mean LSI value
Hattuşa - Kesikkaya Northwest	Karum/Hittite Trans.	0.023256
Hattuşa - Lower Town, South Area	Hittite	-0.0109
Hattuşa - Kesikkaya South	Middle Iron	0.011772
Çadır Höyük	Hittite	0.00748
Çadır Höyük	Early/Middle Iron	-0.02356

Table 5.19 Mean LSI values for Hattuşa and Çadır Höyük sheep samples.

The body size of the sheep in the Karum/Hittite Transitional period sample at Hattuşa Kesikkaya Northwest is very large when placed in relation to the wild female standard. The large body size of the majority of the animals in the sample suggests that specimens in this sample represent mainly adult male animals. The shape of the distribution (mostly large adult males) is in keeping with the classic intensive wool production pattern described by Redding (1984), where adult male castrates are kept in the herd for wool production until wool quality declines in old age and they are killed off for meat. The distribution here could be a sign that intensive wool production was taking place at Kesikkaya Northwest during the Middle Bronze Age. However, it

could also be the result of a provisioning/distribution strategy, where this part of Hattuša was provided with “worn out” old wool animals (from elsewhere) to serve as a source of meat. This pattern is echoed in the caprine survivorship data, where combined sheep and goat mortality for this sample doesn’t peak until later in life, between three to six years (Fig. 5.3b).

At Hittite Lower Town, South Area, we see a population of animals that skews somewhat smaller. The mean is of this distribution is smaller (-0.0109 vs. .023256 in the Kesikkaya Northwest sample) (Table 5.19), and the range extends much further to the left. This pattern suggests a relatively lower proportion of males than what we see in the Karum/Hittite Transitional sample from Kesikkaya Northwest. However, the fact that larger animals (presumably males) still dominate this sample compared to smaller (presumably) female animals likewise may represent an emphasis on secondary product production, particularly wool. This is because, based on most zooarchaeological models of sheep production strategies (i.e. Redding 1984; Payne 1973), males are typically killed off earlier in life when the focus is on other products (i.e. meat or dairy). When we look back at the caprine mortality data for this sample, there is a peak in kill-off between the age of two to three years, when caprines typically reach prime meat weight, and a second smaller peak in kill-off between four to eight years (Fig. 5.3c). This suggests the potential of animals that have been kept until they reach their full size and the maintenance of some animals until later in age, presumably for wool production. The LSI distribution, which includes some very large, presumably male, animals and smaller females, could be reflective of these combined production strategies.

As noted above, the distribution for the Middle Iron Age sample at Kesikkaya South, has multiple modes. More than the two Bronze Age sheep distributions from Hattuša, this sample seems to contain a larger, more visible cluster of smaller (presumably female) animals, ranging

from around -0.08 to -0.015. However, the distribution is still skewed toward the larger, likely older male, animals (toward the right side of the distribution) (Fig. 5.9c). Once again, this may be indicative of a production strategy focused on wool production, where older male animals are kept in the herd longer than they might be otherwise. This possibility is supported by the shape of the caprine mortality histogram for Middle Iron Kesikkaya South (Fig. 5.3d), where kill-off peaks relatively late in life, between three to six years.

#### 5.4.1.2 Çadır Höyük Results

The Hittite sheep LSI distribution at Çadır (Fig. 5.10a) is bimodal and consists of two main clusters. Toward the right side of the graph is a small cluster of larger animals, ranging in size from around 0.04 to 0.06, well above the size of the standard animal, a wild female sheep. Given their large size, these specimens likely represent adult male domesticated sheep. Toward the left side of the graph is a larger cluster of smaller-sized animals, ranging in size from around 0.15 to -0.02, likely representing adult female domesticated sheep (along with potentially some younger males/females). The mean LSI of this distribution is .00748 (Table 5.19).

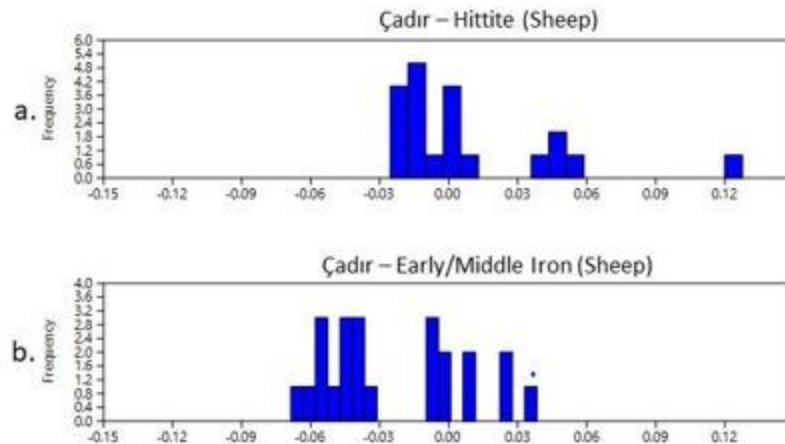


Figure 5.10. Logarithmic size index (LSI) distributions for Çadır Höyük sheep.

Due to sample size, the Early and Middle Iron sheep LSI values were combined for Çadır for this analysis. The Early/Middle Iron sheep distribution is bimodal with two main clusters (Fig. 5.10b). Toward the right side of the graph is a cluster of larger animals, ranging in size from around 0.01 to 0.035, around the same size as to slightly above the size of the standard animal. These values likely represent adult male domesticated sheep. The smaller-sized cluster, which ranges in size from -0.03 to -0.065 likely represents adult female domesticated sheep (along with potentially some younger males/females). The mean LSI value of this distribution is -0.02356 (Table 5.19).

Based on the distribution of animals, female sheep seem to greatly outnumber males in the Hittite sample at Çadır. This pattern would be in keeping with a production strategy that minimizes risk and emphasizes herd security, where a smaller number of adult males is kept for breeding purposes (Redding 1984; Payne 1973). This interpretation would be in keeping with the possibility, discussed above, that the Hittite period caprine mortality profile for Çadır could

represent a conservative herding strategy where animals were being kept alive past prime meat weight.

During the Early/Middle Iron Age at Çadır, larger (presumably male) animals and smaller (presumably female) animals are represented in roughly even proportions. The fact that there are many smaller female animals may point toward a conservative, low risk production strategy. This would be in line with the interpretation of the Early Iron caprine mortality results (Fig. 5.5c). However, it is difficult to say with certainty given the blurring that results from combining the sheep metrical data from the Early and Middle Iron Age periods and from the fact that the survivorship/mortality histograms combine age data from both sheep and goats.

What does seem clear is that the body size of the sheep sample from the Early and Middle Iron Ages at Çadır is smaller overall than the sample from the Hittite period. The Hittite LSI values range from approximately -0.025 to 0.06 (excluding an especially large sheep specimen that appears around 0.0125) while the Iron Age values range from approximately -0.07 to .035. This difference suggests that a change occurred within the sheep population at Çadır following the Hittite collapse, with male and female animals both becoming smaller, potentially indicating that a new population of sheep was introduced at the site during the Iron Age. When these two samples (Hittite and Iron) were compared using a Mann-Whitney pairwise test, there was a statistically significant difference between them ( $p=2.88E-06$ ).

#### 5.4.1.3 Hattuşa vs. Çadır Sheep Metrical Comparison

The five Bronze and Iron Age sheep samples Hattuşa and Çadır were examined statistically using a one-way ANOVA test. The results of this test suggest that the likelihood of the sample populations from the same population is very low. In other words, it suggests that

there is a statistically significant difference between the sheep populations included here ( $df=169$ ;  $F=6.752$ ;  $p=4.671E-05$ ). When examined using a Mann-Whitney pairwise test, there is a statistically significant difference ( $p=.01001$ ) between the Karum/Hittite Transitional period sample at Hattuşa Kesikkaya Northwest and the Hittite period sample at Hattuşa Lower Town, South Area. Using the same test, there is also a statistical difference between the sample at Hattuşa Kesikkaya Northwest and both the Hittite and Early/Middle Iron Age samples at Çadır ( $p=0.01968$  and  $p=2.88E-06$ , respectively). Likewise, there is a statistically significant difference between the Iron Age samples at Hattuşa Kesikkaya South and Çadır ( $p=000825$ ).

Visually, when comparing the Bronze Age distributions at Hattuşa vs. Çadır, there are proportionally more smaller, female-sized animals at Hittite period Çadır (Fig. 5.10a) than in the Bronze Age samples from Hattuşa (Fig. 5.9ab), where the distributions skew heavily toward larger, male-sized animals. This likely reflects differences in production/provisioning strategies at the two sites during the Middle/Late Bronze Age, as discussed above. Likewise, differences in production strategies seem likely when comparing the Early/Middle Iron distribution at Çadır to the distribution at Middle Iron Kesikkaya South at Hattuşa. Generally speaking, in terms of production strategies, the distributions at Hattuşa seem to be more reflective of an emphasis on secondary products production while those at Çadır appear to be more focused on herd security.

Also worth noting is the fact that, within the Bronze Age samples across both sites, there is an abundance of very large bodied sheep that exceed the size of the standard animal. This is still the case at Hattuşa Kesikkaya South during the Middle Iron Age, but sheep body size decreases considerably at Çadır during the Early and Middle Iron Ages.

## 5.4.2 Goat Biometrics Results

### 5.4.2.1 Hattuša Goat Biometric Results

The goat LSI distribution for the Karum/Hittite Transitional period sample at Hattuša Kesikkaya Northwest (Fig. 5.11a) skews heavily to the left, well below the size of the standard animal. A smaller number of specimens extends toward the right side of the distribution. Given the pronounced sexual dimorphism between male and female goats (Zeder 2001), it is likely that the large cluster of animals with small body sizes on the left side of the distribution (with a mode between approximately -0.08 and -0.05) represents females and that the smaller number of individuals on the right side of the distribution represents large-bodied males. This distribution, where a herd of goats is comprised of mostly females (and younger animals), and only a few adult males are kept for breeding purposes, is fairly common in goat production, and typically signifies a production strategy that emphasizes herd security (Redding 1984).

The metrical data from the goats at the Hittite Lower Town, South Area, were excluded due to sample size. The distribution of goat LSI values at Kesikkaya South during the Middle Iron Age (Fig. 5.11b) skews heavily to the right, and all values fall below the size of the standard animal. A smaller number of specimens extends toward the left side of the histogram. Again, given the pronounced sexual dimorphism in goats, it is likely that the animals on the right side of the histogram (with a mode at -0.025) represent males and that the smaller number of small-bodied animals extending to the left represents females.

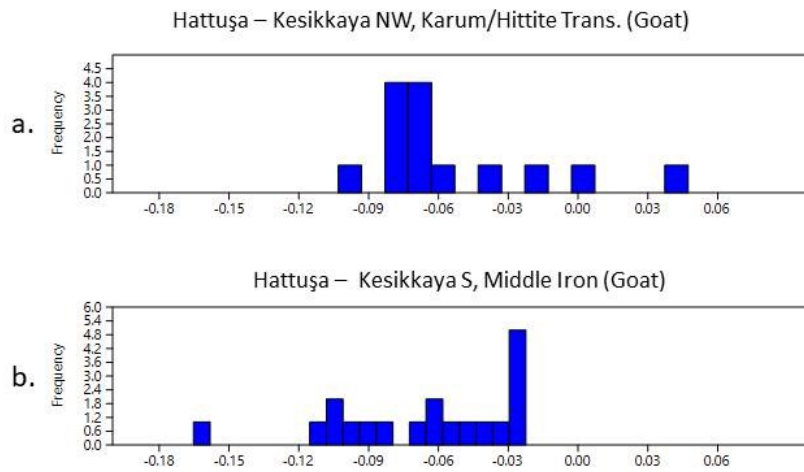


Figure 5.11. Logarithmic size index (LSI) distributions for Hattuša goats.

Curiously, these two distributions from different periods and excavation areas at Hattuša are almost mirror images of one another. It is possible that the sample from Middle Iron Kesikkaya South represents the off-take of males from a production strategy like the one described for Karum/Hittite Transitional Kesikkaya Northwest. If this is the case, it is possible that Middle Iron Kesikkaya South was being provided with male goats (for meat) that were not needed for herd maintenance. Alternatively, the high proportion of male vs. female goats in this sample could point toward a production strategy with an emphasis on hair production. The mean LSI values for these two samples are quite similar:  $-0.05394$  at Karum/Hittite Transitional Kesikkaya Northwest and  $-0.06482$  at Middle Iron Kesikkaya South (Table 5.20).

Site	Period	Mean LSI value
Hattuşa - Kesikkaya Northwest	Karum/Hittite Trans.	-0.05394
Hattuşa - Kesikkaya South	Middle Iron	-0.06482
Çadır Höyük	Hittite	-0.07899
Çadır Höyük	Early/Middle Iron	-0.06231

Table 5.20 Mean LSI values for Hattuşa and Çadır Höyük goat samples.

#### 5.4.2.2 Çadır Höyük Results

The majority of the specimens in the sampled population of goats at Hittite Çadır (Fig. 5.12a) are much smaller than the size of the standard animal (the average of a male and female wild goat). While the sample size is small, the distribution appears to be bimodal, with the smaller mode occurring around -0.10 and the larger mode occurring around -0.015. Given the pronounced sexual dimorphism of goats and that unfused specimens have been excluded from the analysis (limiting the number of younger animals in the sample) that the specimens with LSI values clustering around the smaller mode represent females and that the specimens with LSI values at the larger mode represent males. If this is the case, smaller female goats vastly

outnumber larger males in this sample, which would be in keeping with models for conservative herding strategies.

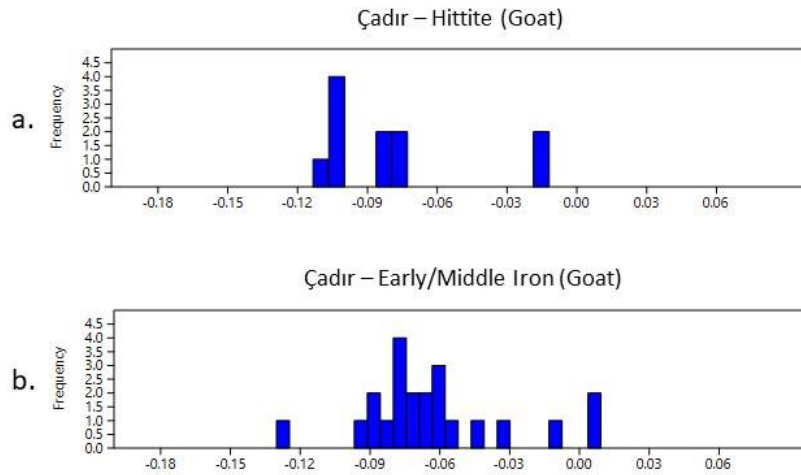


Figure 5.12 Logarithmic size index (LSI) distributions for Çadır Höyük goats.

For Çadır during the Early and Middle Iron Ages (Fig. 5.12b), the distribution of goat LSI values skews heavily to the left. On the left side of the graph is a large cluster of specimens with LSI values that peak at approximately -0.08. A smaller number of specimens with higher LSI values extends toward the right side of the histogram, with a maximum LSI value of approximately 0.01. As is the case for the Hittite period, the specimens with LSI values clustering around the smaller mode likely represent females and that the small number of specimens with higher LSI values likely represent males, again representing a conservative

herding strategies where a few males are allowed to reach adulthood and are maintained in order to maintain the herd.

Generally speaking the shapes of the two goat LSI value distributions at Çadır appear to be quite similar. In both cases there is a higher proportion of smaller (presumably female) animals relative to larger (presumably male) animals. Moreover, the mean LSI values for these distributions are quite similar: -0.07889 during the Hittite period and -0.06231 during the Early/Middle Iron Age (Table 5.20). These similarities suggest continuity in goat management across the Bronze/Iron transition at Çadır.

#### 5.4.2.3 Hattuşa vs. Çadır Höyük Goat Metrical Comparison

The four Bronze and Iron Age goat samples Hattuşa and Çadır were examined statistically using a one-way ANOVA test. The results of this test suggest that the likelihood of the sample populations coming from the same population is very high. In other words, it suggests that there is not a statistically significant difference between the goat populations represented here ( $df=65$ ;  $F=.9907$ ;  $p=.4031$ ). When examined using a Mann-Whitney pairwise test, there was no statistically significant difference between the four samples (for all pairs,  $p>.05$ ).

Visually, the shapes of the LSI value distributions for Karum/Hittite Transitional Kesikkaya Northwest at Hattuşa, Hittite Çadır, and Early/Middle Iron Çadır are very similar, with a higher proportion of smaller (presumably female) animals relative to larger (presumably male) animals. This pattern, combined with the statistical results, suggests a great deal of consistency in goat management practices across sites and periods.

### *5.4.3 Cattle Biometrics Results*

#### 5.4.3.1 Hattuša Results

The majority of the cattle specimens in the sample from the Karum/Hittite Transitional period at Hattuša Kesikkaya Northwest (Fig. 5.13a) have LSI values ranging from around -0.06 to .085. Within this distribution, the two largest modes occur between the LSI values of 0.01 and 0.05, a little larger than the size of the standard animal. The mean LSI value of this distribution is .008605 (Table 5.21). Because there is often overlap in the size of range of adult male and female cattle (Helmer et al. 2005), the biometric distributions for male and female cattle when represented as LSI values can overlap considerably. With this taken into consideration, it seems possible that the mode that occurs around 0.01 represents smaller-bodied female (and younger) animals and the mode that occurs around 0.05 represents slightly larger-bodied adult male cattle and castrates.

The distribution of cattle at Hittite Lower Town, South Area (Fig. 5.13b) has LSI values ranging from approximately -0.05 to 0.05, evenly straddling the size of the standard animal (a domesticated cow). The mode of this distribution occurs around 0.02, and the mean LSI value occurs at -0.00224 (Table 5.21). When placed in relation to the other cattle LSI value distributions from Hattuša and Çadır, it seems likely that this size distribution represents mostly cows, with bulls and oxen being largely absent. The reasoning behind this interpretation is discussed in greater depth below.

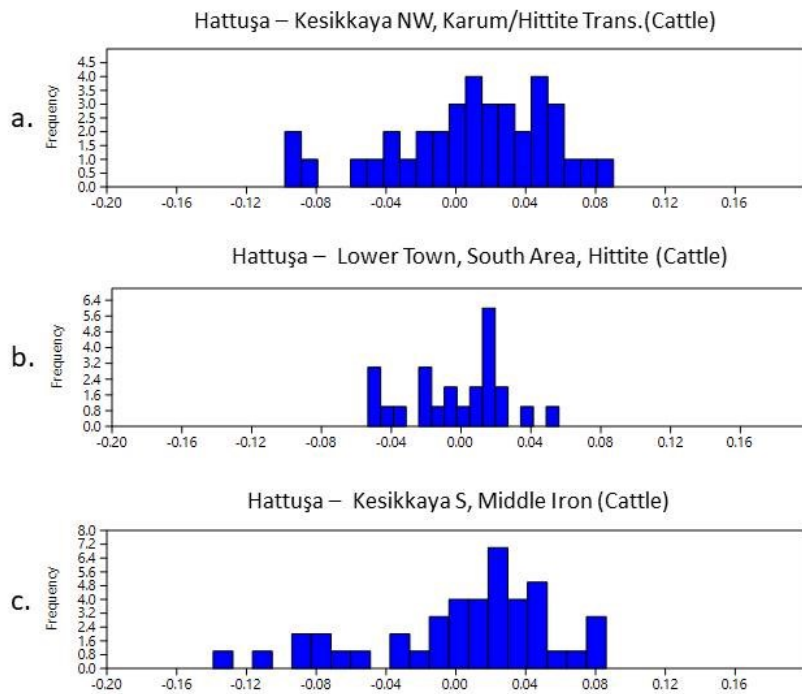


Figure 5.13 Logarithmic size index (LSI) distributions for Hattuša cattle.

The distribution of cattle LSI values at Kesikkaya South during the Middle Iron Age (Fig. 5.13c) skew toward the left, with the mode occurring around 0.025. Assuming that the very small LSI values likely represent juveniles (which may appear in these samples through early-fusing elements), the bulk of the distribution ranges from approximately -0.04 to 0.085, with a small peak occurring at .085. The mean LSI value of this distribution is 0.004475 (Table 5.21). It is possible that the specimens with LSI values around the 0.085 peak represent a small number of

larger adult males or oxen, and that much of the remainder of the distribution, ranging from approximately -0.04 to 0.04, represents adult female animals.

Site	Period	Mean LSI value
Hattuşa - Kesikkaya Northwest	Karum/Hittite Trans.	0.008605
Hattuşa - Lower Town, South Area	Hittite	-0.00224
Hattuşa - Kesikkaya South	Middle Iron	0.004475
Çadır Höyük	Hittite	0.022323
Çadır Höyük	Early/Middle Iron	0.009137

Table 5.21 Mean LSI values for Hattuşa and Çadır Höyük cattle\* samples  
\*excluding specimens that may be aurochs

In the Karum/Hittite Transitional sample from Kesikkaya Northwest and in the Middle Iron sample from Kesikkaya South, the main part of the cattle LSI distribution extends from around -0.04 to 0.08 (Fig. 5.13ac). In both of these cases, there is a mode around 0.01 (Kesikkaya Northwest) or 0.02 (Kesikkaya South), around which many of the LSI values cluster. This is followed by a second, smaller peak around 0.05. Given the overlapping body ranges of male and female cattle, it seems likely that the bulk of these specimens (those clustering around the first mode [0.01-0.02]) represent smaller adult females and the second (smaller) peak represents larger adult males. If this is the case, then both of these distributions represent a herd structure where only a relatively small number of males is allowed to reach adulthood, either for traction (oxen) or for breeding purposes (bulls), and the majority of the herd is comprised of adult females (for breeding/dairy production). This cattle herd structure is a fairly common one in the ancient Near East (Arbuckle 2014).

In contrast to what we observe at Kesikkaya Northwest and Kesikkaya South, the cattle LSI value distribution at the Hittite Lower Town, South Area almost completely lacks specimens

with LSI values above 0.03 (Fig. 5.13b). However, the mode of the distribution (0.025) is fairly close to the modes for the “adult female-sized” distributions at Kesikkaya Northwest (Karum/Hittite Transitional) and Kesikkaya South (Middle Iron). Its range is also roughly in keeping with the “adult female-sized” distributions from these samples. Assuming there is no major size difference in the cattle populations across these three samples, this similarity suggests that the vast majority of the cattle specimens in the Hittite Lower Town, South Area may belong to female cattle and that male cattle are mostly absent from this area of the site during the Hittite period.

#### 5.4.3.2 Çadır Höyük Results

The LSI values of the cattle specimens in the sample from Hittite Çadır (Fig. 5.14a) range primarily between -0.06 and 0.10. The largest specimen in the sample, with an LSI value of approximately .130 may be an aurochs (*Bos primigenius*, a species of large wild cattle). This distribution is bimodal, with the larger mode occurring around 0.07 and a smaller mode around 0.01. Though there is often overlap in the size ranges of male and female cattle (Helmer et al. 2005), it seems likely that the LSI values around the larger mode (0.07) represent larger bulls or oxen and that the LSI values around the smaller mode (0.01) represent smaller cows and younger animals.

The Early/Middle Iron Age cattle size distribution at Çadır (Fig. 5.14b) is distributed in two main clusters that overlap fairly well with the bimodal size distribution of the Hittite period at the site. The first cluster, which contains specimens with LSI values representing smaller-bodied animals, has LSI values ranging from approximately -0.04 to 0.04. The second cluster, which contains specimens with LSI values ranging from approximately 0.06 to 0.10, represents

larger-bodied animals. It is possible that these clusters represent adult female and adult male animals respectively. Given their large size, the specimens with LSI values of 0.13 and 0.16 may represent aurochs. The mean for this sample is .009137 (Table 5.21).

Based on these interpretations, both the Hittite and Iron Age distributions at Çadır likely represent a herd structure where only a relatively small number of males is allowed to reach adulthood, either for traction (oxen) or for breeding purposes (bulls), and the majority of the herd is comprised of adult females (for breeding/dairy production).

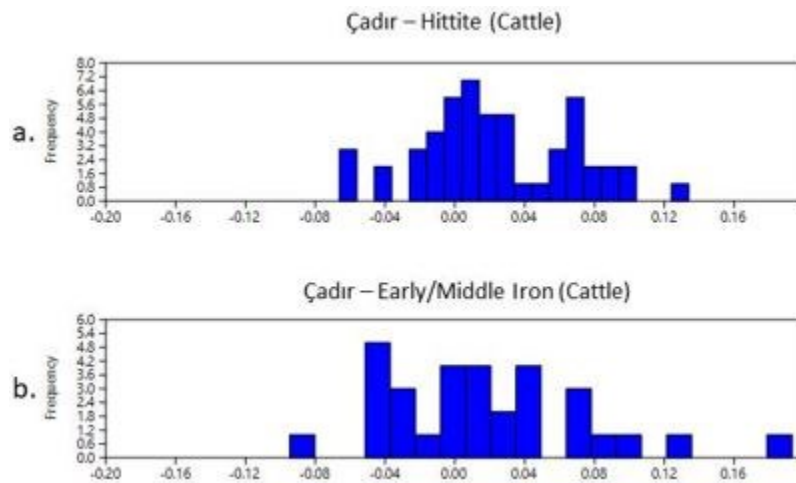


Figure 5.14 Logarithmic size index (LSI) distributions for Çadır Höyük cattle.

#### 5.4.3.3 Hattuşa vs. Çadır Höyük Cattle Metrical Comparison

The five Bronze and Iron Age goat samples Hattuşa and Çadır were examined statistically using a one-way ANOVA test. The results of this test suggest that the likelihood of the sample populations deriving from the same population is very high. In other words, it suggests that there is not a statistically significant difference between the cattle populations

represented here ( $df=187$ ;  $F=1.89$ ;  $p=.114$ ). When examined using a Mann-Whitney pairwise test, the only pair with a result suggesting a likelihood of difference was the comparison of Hittite Çadır with Hittite Hattuşa, Lower Town, South Area ( $p=.02249$ ).

Generally speaking, the ranges for the “female-sized” and “male-sized” animals across these distributions are quite similar (approximately  $-0.04$  to  $0.05$  and  $.06$  to  $.10$  respectively). The relatively small number of samples with smaller LSI values may represent juveniles. In every case but Hittite Lower Town, South Area, “female-sized” animals appear in greater proportion, with a much smaller number of larger “male-sized” animals, probably kept in the herd for breeding and/or traction. This pattern, combined with the statistical results, where statistical differences between sample populations were limited, suggests a great deal of consistency in cattle management practices across sites and time periods.

## **5.5 Skeletal Parts**

### *5.5.1 “Caprine-Sized” Skeletal Parts*

#### 5.5.1.1 Hattuşa Results

During the Karum/Hittite Transitional period at Kesikkaya Northwest, the mandible (MNE=30) and the proximal radius (MNE=30) are the most commonly occurring caprine elements (Fig. 5.15a). These elements belong to the head and the forelimb respectively; however, elements from a variety of body zones including the axial skeleton (the axis, MNE=21) and the extremity (proximal metacarpal, MNE=25). When body zones are examined using MAU% (Fig. 5.16a), the caprine-sized Karum/Hittite Transitional distribution is fairly “flat” or even – all parts of the carcass are present in relatively even proportions. Within the distribution, the head, axial skeleton, and forelimb are slightly over-represented (by 4%, 5% and 4% respectively), and the

hindlimb and extremity are slightly under-represented (both by approximately 4%). The pelvis is the least represented body zone (approximately 7% under-represented). The lower relative proportions of the elements comprising the pelvis (the ischium is the most abundant, with an MNE of 17) could be related to density mediated attrition. For the most part, the skeletal part patterns from this sample are consistent with what we would expect to see if butchery and consumption activities were occurring in the same area.

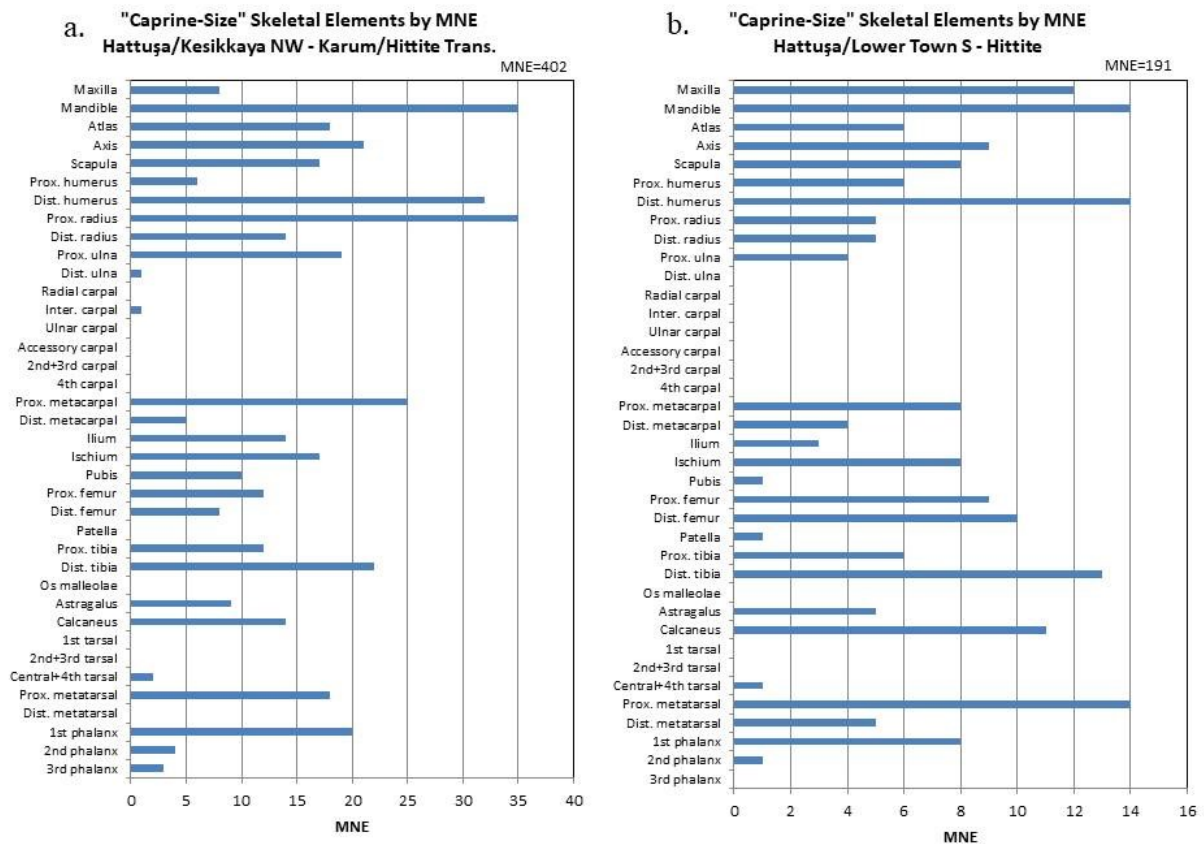


Figure 5.15 Hattuša “caprine-size” elements by MNE (part 1)

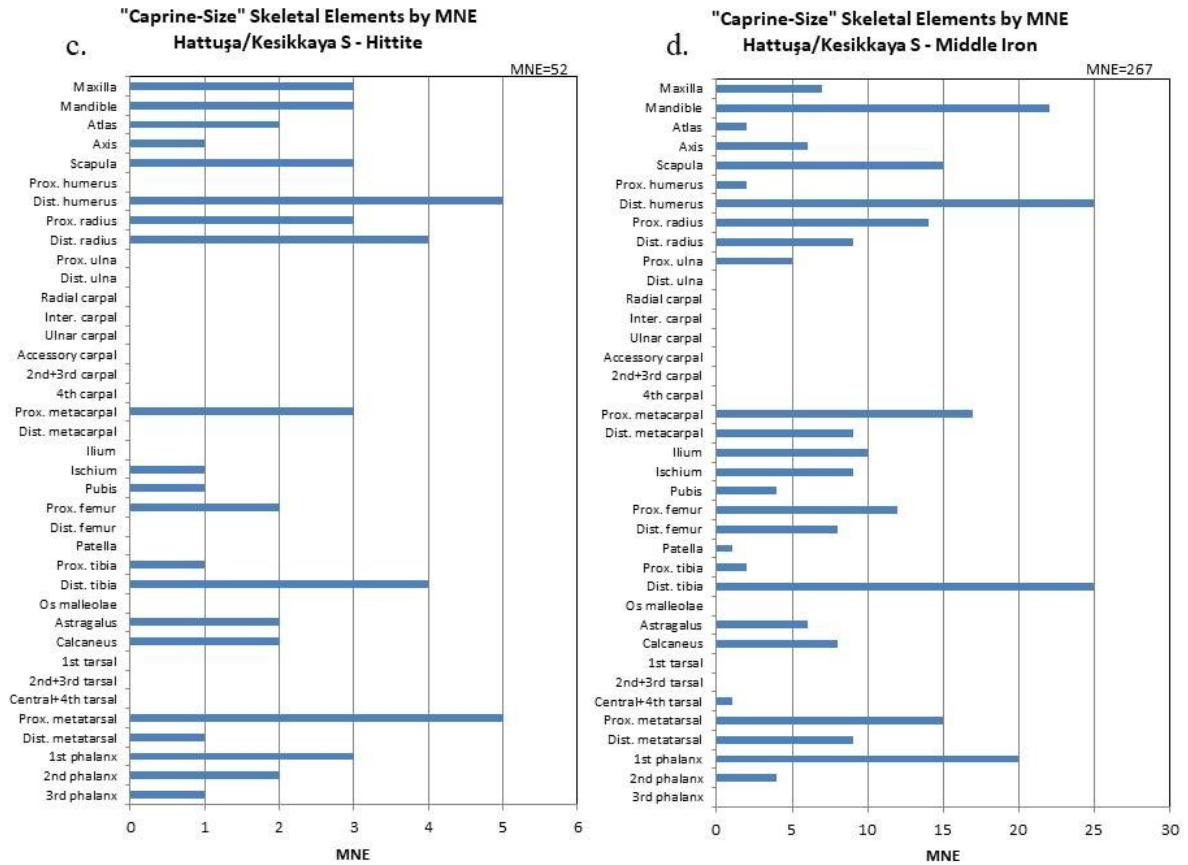


Figure 5.15 Hattusa “caprine-size” elements by MNE (part 2)

During the Hittite period at the Lower Town, South Area (Fig. 5.15b), three elements tie for greatest abundance: mandible, distal humerus, and proximal metatarsal (for each, MNE=14). The distal tibia (MNE=13). All six body zones are fairly well-represented in terms of the distribution of elements. This pattern can also be seen reflected relative distributions of body zones when examined by MAU% (Fig. 5.16b). The distribution is fairly “flat” or even – all parts of the carcass are present in relatively equal proportions. The head, forelimb, hindlimb, and extremity all fall within 3% of the “zero” axis – in other words, they are, essentially, neither over- nor under-represented. The axial skeleton is somewhat over-represented (by 6%), and the

pelvis is somewhat under-represented (by 6%). Given the generally flattened distribution, the skeletal part patterns from this sample are consistent with what we would expect to see if butchery and consumption activities of caprine-sized animals were occurring in the same area.

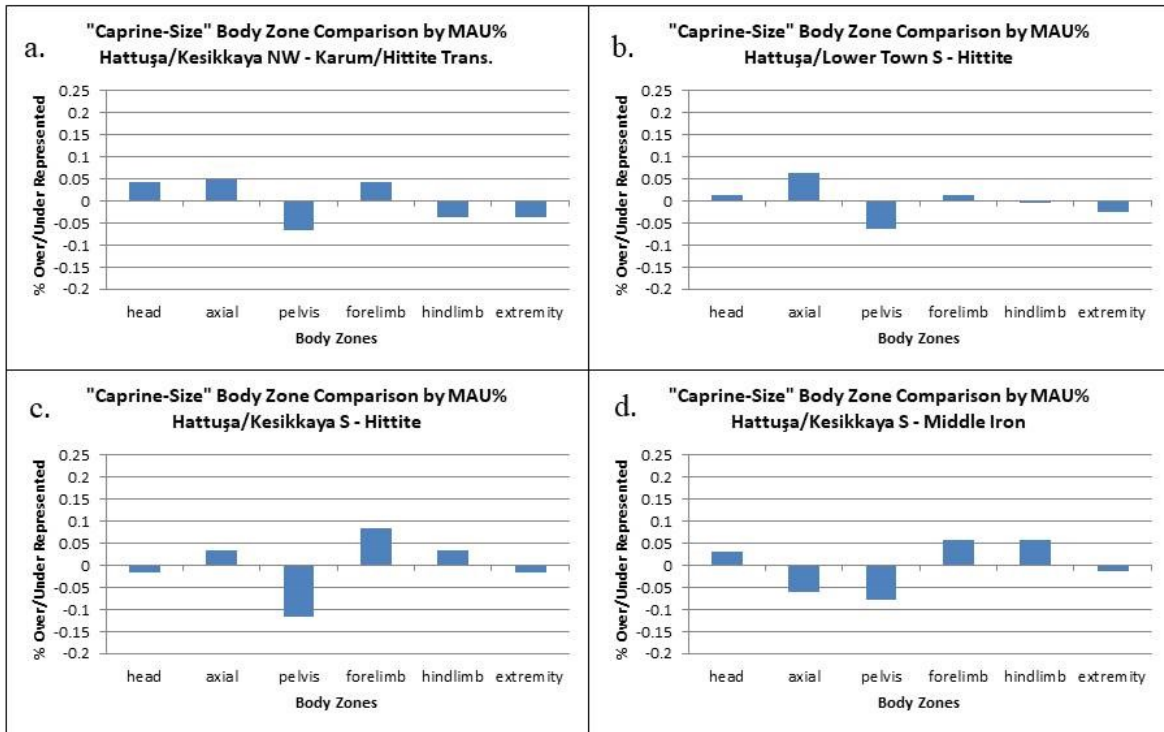


Figure 5.16 Hattuša “caprine-size” body zone distributions by %MAU.

In the Hittite period caprine-sized sample at Kesikkaya South (Fig. 5.15c), distal humeri and proximal metatarsals appear with the greatest frequency (for each MNE=5). Within this assemblage, the representation of bones from the pelvis is noticeably small (ischium, MNE=1; pubis, MNE=1). When body zones are examined by MAU% (Fig. 5.16c), the forelimb is the most over-represented area of the body (by 8%). The pelvis is the most under-represented (by

12%). The other areas of the body (head, axial skeleton, hindlimb, extremities) are neither over nor under-represented (ranging between 1 and 3% from the “zero” axis). The strong under-representation of bones from the pelvis and the over-representation of the forelimb are interesting departures here from what otherwise would read as a fairly even distribution of body parts. The under-representation of pelvis bones may be affected by density mediated attrition. However, if we recall that an under-representation of 16.67% occurs when all elements from a given body zone are missing, the strong degree of pelvis under-representation (12%--nearly all of the pelvis bones from this sample), suggests that cuts of meat from this part of the body may have been distributed differently (and ultimately, the bones deposited elsewhere).

Within the caprine-sized Hittite assemblage from Kesikkaya South (Fig. 5.15d), the distal humerus and the distal tibia are the best-represented elements (for both, MNE=25). They are followed in frequency by the mandible (MNE=22), the first phalanx (MNE=20), and the proximal metacarpal (MNE=17). When this sample is examined by MAU% (Fig. 5.16d), the forelimb and the hindlimb have the greatest abundance (over-represented by 6%), but the degree of over-representation is not extreme. The pelvis and the axial skeleton are both under-represented (by 8% and 6% respectively). The head and extremities are neither over- nor under-represented.

Variation between the caprine-sized body zone distributions of the four Hattuša samples is fairly minimal (Fig. 5.16), particularly compared to some of the extremes in the cattle assemblages above. With a few exceptions, all over- or under-representation of body zones for the time periods/excavation areas included here fall within approximately 6% of the “zero” axis. The most notable exception is for Hittite period Kesikkaya South (Fig. 5.16c), where caprine-sized pelvic elements are under-represented (by around 12%), and there is an over-abundance of

forelimbs (over-represented by 8%). This pattern may be suggestive of indirect provisioning in this area of the site during the Hittite period.

None of the four caprine-sized samples from Hattuša displays an over-abundance of specimens typically identified as butchery waste (i.e. heads, extremities). Nor is there a major over-abundance of meat rich elements (forelimb, hindlimb). For the most part, the relatively even body part distributions in the Karum/Hittite Trans. Kesikkaya Northwest; Hittite Lower Town, South Area; and Middle Iron Kesikkaya South assemblages (Figs. 5.16abd), where no body zone is notably under- or over-represented, are suggestive of patterns where butchery and consumption activities were occurring in the same place.

#### 5.5.1.2 Çadır Höyük Results

During the Hittite period at Çadır (Fig. 5.17a), first phalanges (MNE=19), mandibles (MNE=17), astragali (MNE=17), and distal humeri (MNI=16) are the most abundant caprine-sized elements. The areas of the body associated with these elements are also the most strongly represented when the assemblage is examined by MAU% (Fig. 5.18a). Forelimbs are the most over-represented body area (by 11%), followed by heads and extremities (both over-represented by 7%). On the flip side, elements of the axial skeleton have a very lower frequency (atlas, MNE=2; axis, MNE=2). When calculated by MAU%, it becomes clear that the axial skeleton is largely absent (under-represented by 11%), followed closely by the pelvis (under-represented by 10%). The hindlimb area is only somewhat under-represented (by 4%). This assemblage is interesting in that it has an over-representation (by 7%) of parts of the body (the head and extremities) often associated with butchery activities. At the same time, there is also an over-

abundance (by 11%) of meaty forelimbs. The absence of the other body zones (particularly the pelvis and the axial skeleton, which are the most-under-represented) could be related to density.

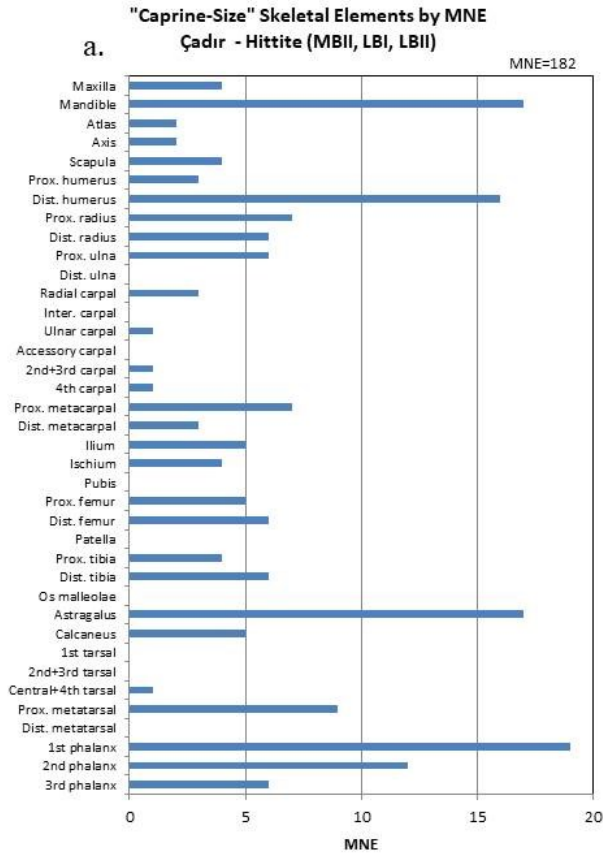


Figure 5.17 Çadır “caprine-size” elements by MNE (part 1)

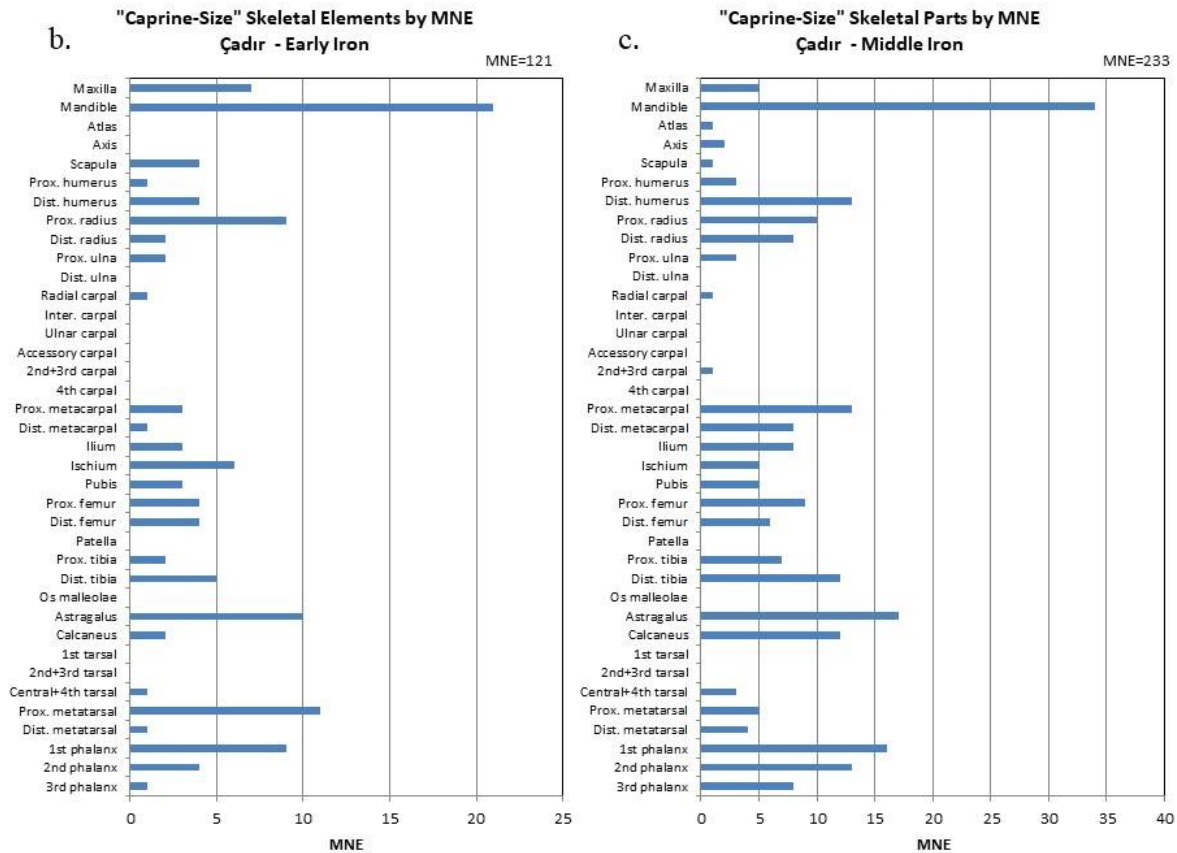


Figure 5.17 Çadır “caprine-size” elements by MNE (part 2)

During the Early Iron Age at Çadır, mandibles are by far the most abundant caprine-sized element (MNE=25) (Fig. 5.17b). The next most abundant element, the proximal metatarsal only has an MNE of 11. It is followed closely by the astragalus (MNE=10), and the proximal radius (MNE=9). The elements of the axial skeleton (atlas and axis) are completely absent. When examined by MAU% (Fig. 5.18b), caprine-sized heads during the Early Iron Age are extremely over-represented (by 24%). In essence, this skew means that this assemblage is made up mostly of head elements. All other body parts are either right on the “zero” line or are under-represented. This pattern, which includes an extreme over-abundance of caprine-sized heads,

which far outnumber any other element, likely represents butchery waste and the separation of butchery from consumption.

The shape of the Middle Iron caprine-sized distribution at Çadır (Fig. 5.17c) is quite similar to what we see in the Early Iron Age. Once again, the mandible is by far the most abundant element (MNE=34). It is followed in abundance by the astragalus (MNE=17), the first phalanx (MNE=16), and the distal humerus and proximal metacarpal (for each, MNE=13). As was the case in the Early Iron MAU% body part distribution, in the Middle Iron distribution (Fig. 5.18c), the head is extremely over-represented (by 22%). The second-most abundant body zone, the extremity, is over-represented by a mere 3%. All other body zones are under-represented to varying degrees, especially the axial skeleton (by 12%) and the pelvis (by 8%).

In terms of caprine-sized body zone representation at Çadır, there is a noticeable shift from the Hittite period into the Iron Age. During the Hittite period, limb bones are the most abundant body zone: forelimbs are over-represented by 11% in the Hittite period. Moving into the Iron Age, however, there is a strong decrease in the relative proportions of limb bones and a dramatic decrease in the proportion of head bones, from 6% over-represented in the Hittite period to 24% over-represented in the Early Iron Age. Both of these patterns are suggestive of the presence of specialized provisioning (where butchery and consumption activities occur in separate areas). However, in the Hittite period, we see evidence for possible consumption activities, whereas during the Iron Age we see evidence for butchery activities, suggesting differences in how provisioning was organized before and after the Hittite collapse at the site.

### 5.5.1.3 Hattuša vs. Çadır Höyük “Caprine-Sized” Skeletal Parts Comparison

Generally speaking, caprine-sized samples we’ve observed at Hattuša (Fig. 5.16) from the Bronze and Iron Ages have a more even (flatter) distribution of body parts (i.e. a smaller degree of over or under-representation) than those at Çadır (Fig. 5.18). These results are particularly interesting in that they suggest, for caprines, that a stronger degree of separation between butchery and consumption activities (associated with specialized butchery and provisioning systems) seems to have been happening at Çadır than at Hattuša during these periods. Also worth repeating is that there is an apparent shift in the organization of butchery/provisioning at Çadır across the Bronze/Iron transition, accompanying the Hittite collapse.

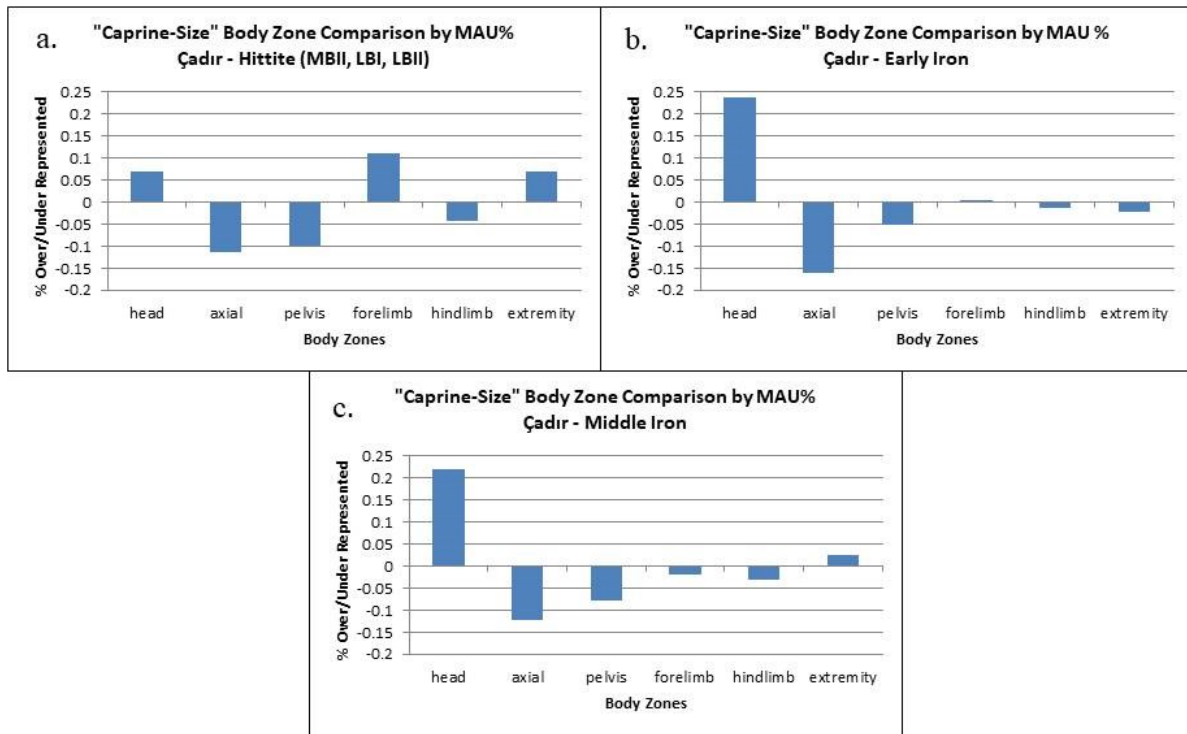


Figure 5.18 Çadır “caprine-size” body zone distributions by %MAU.

## 5.5.2 “Cattle-Sized” Skeletal Parts Results

### 5.5.2.1 Hattuşa Results

During the Karum/Hittite Transitional period at Kesikkaya Northwest, the ischium (MNE=12) is the most commonly occurring cattle-sized element when skeletal elements are calculated by the minimum number of elements (MNE) (Fig. 5.19a). The ilium follows closely behind (MNE=11). Elements from the head (mandible and maxilla) and the axial skeleton (atlas, axis) are among the most poorly represented (for mandible, maxilla, and atlas, MNE=2; axis MNE=1). Given the high representation of the ilium and ischium, which are not very dense

elements, and the low representation of mandibles, which are quite dense, these signatures suggest that the skeletal element patterns in this sample are likely attributable to factors beyond density mediated attrition.

When examined by minimum animal unit (MAU), which corrects for the over-representation of skeletal elements that occur more than once in the body, all parts of the skeleton are present in the cattle-sized sample from the Karum/Hittite transitional period at Kesikkaya Northwest (Fig. 5.20a). Heads and axial elements are somewhat under-represented (by approximately 12% and 6% respectively), which dovetails with the MNE results described above, and pelvises and hindlimbs are slightly over-represented (by around 9% and 6% respectively).

In the Hittite assemblage from the Lower Town, South Area (Fig. 5.19b), proximal and distal metacarpals are the most represented cattle-sized elements (proximal MNE=8; distal MNE=7). In general, within this sample, bones from the extremities are very well-represented, with a high incidence of carpal and tarsal bones as well. Outside of the extremity region, the distal humerus is the element with the next-greatest frequency (MNE=5). Atlas and axis are completely absent, and elements from the head and the pelvic girdle are present only in very low numbers.

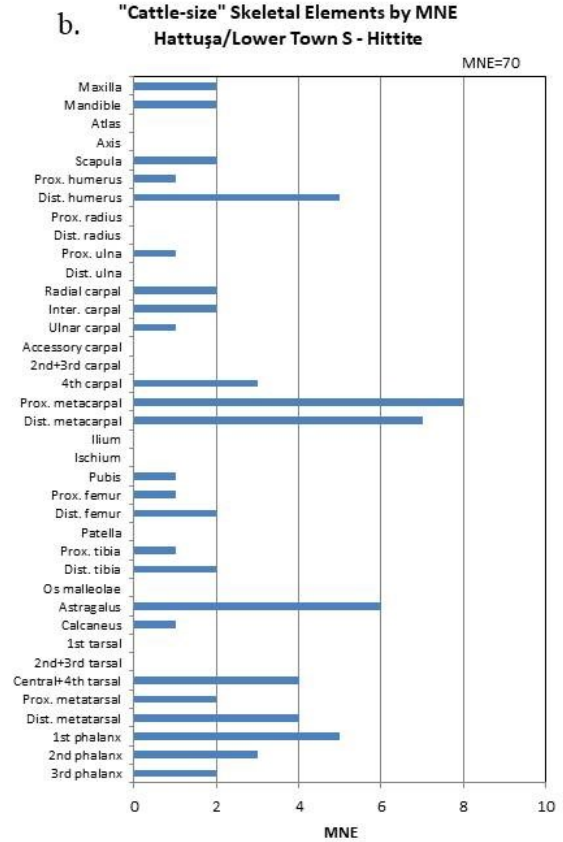
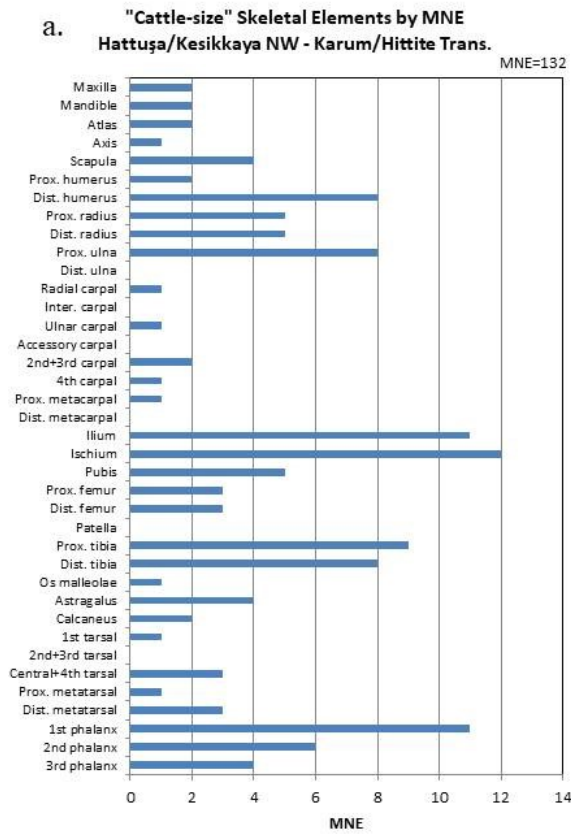


Figure 5.19 Hattuša “cattle-size” elements by MNE (part 1)

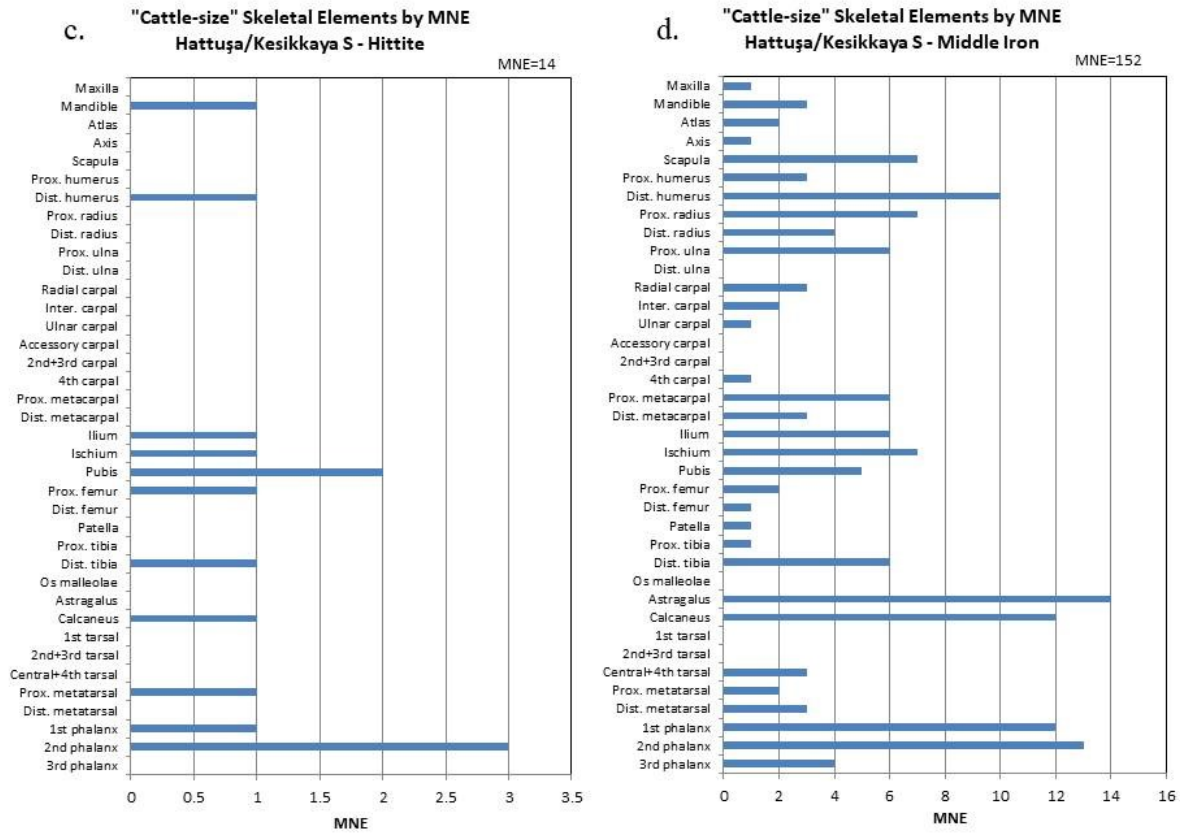


Figure 5.19 Hattuša “cattle-size” elements by MNE (part 2)

When examined by minimum animal unit (MAU) (Fig. 5.20b), the extremity category is noticeably over-represented (by 30%) within the Hittite period Lower Town South Area cattle-sized assemblage. Forelimbs are also over-represented, but this case isn't as extreme (forelimbs extend above the “zero” axis by approximately 9%). All other body zones in this assemblage are under-represented, ranging from 16% under-represented (the axial skeleton) to 6% underrepresented (head and hindlimb).

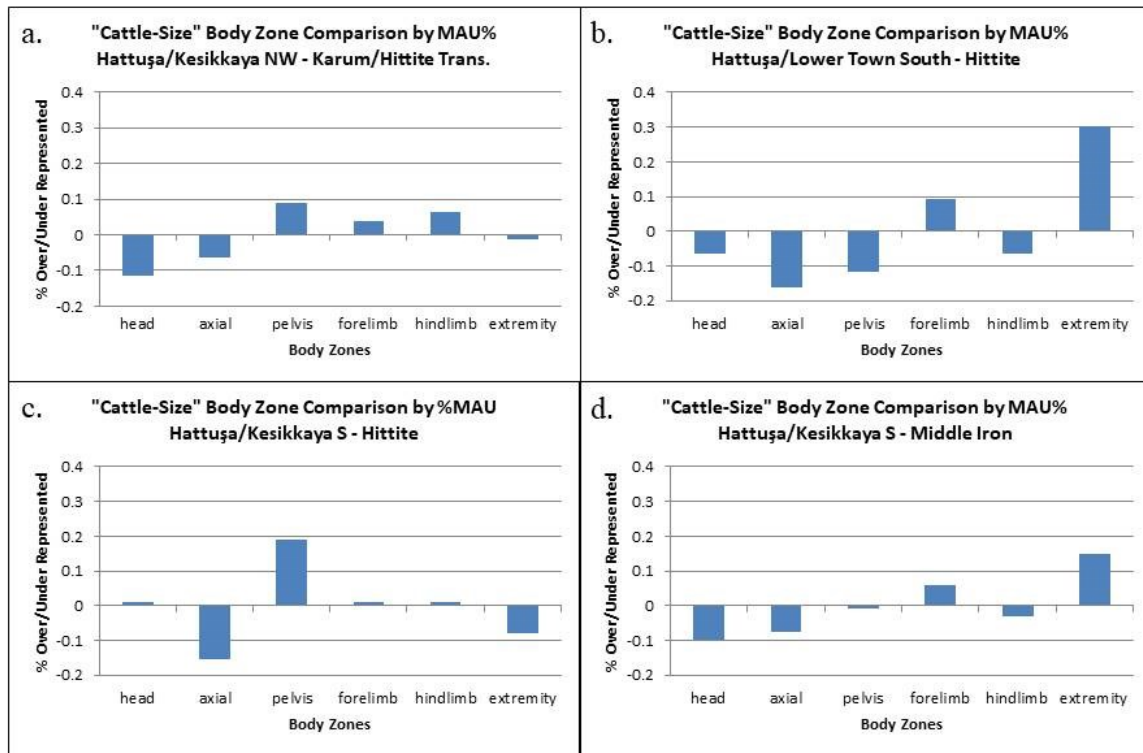


Figure 5.20 Hattuša “cattle-size” body zone distributions by %MAU.

The cattle-sized Hittite period sample at Kesikkaya South (Fig. 5.19c) is relatively small, so MNEs are low. Second phalanges have the highest frequency (MNE=3), but this number somewhat misleading given that this element occurs eight times in cattle-sized animals (so the second phalanx MAU=.375). The element with the second-highest frequency is the pubis (MNE=2). This is also reflected in the MAU% calculation (Fig. 5.20c), where cattle sized pelvic elements have the highest representation in the sample (19% over-represented). Axial elements, on the other hand, are under-represented (by 15%), as are extremities to a lesser degree (by 8%). Simultaneously, the proportions of the remaining three body zone categories (head, forelimb, and

hindlimb) are neither under- nor over-represented (falling very close to the “zero” axis in Fig. 5.20c).

Extremities are among the best represented cattle-sized elements at Middle Iron Kesikkaya South (Fig. 5.19d). Astragali have the highest representation (MNE=14), followed by calcanei (MNE=12). Another “peak” in the MNE histogram is created by distal humeri (MNE=10). Elements from the head (mandibles, maxillae) and axial skeleton (atlas and axis) are among the most poorly represented areas of the body (MNE values ranging from 1 to 3). When examined by MAU%, the Middle Iron Age materials from Kesikkaya South (Fig. 5.20d) display an over-representation of extremities (by approximately 15%). Within this assemblage, heads are somewhat under-represented (by approximately 10%), as is the axial skeleton (by around 8%). Forelimbs are marginally over-represented (by around 6%), and hindlimbs and pelvis elements are neither over- nor under-represented.

Generally speaking, the under-representation of axial elements in many of these assemblages is likely taphonomic, given that axial elements are not very dense, and thus are particularly vulnerable to density-mediated attrition. However, for the purposes of this analysis, other anatomical regions are less affected by this issue given that MNE values were taken from the best preserved skeletal part for each element (e.g. for long bones, the proximal vs. distal end) and that, out of these calculations, MNE values were taken from the best preserved element.

Notable within these samples is the high over-representation of extremities (by 30%) at Hittite period Lower Town, South Area (Fig. 5.20b). Given the general association between extremities and butchery waste (Russell and Martin 2005), this pattern may be indicative of a trash deposit. Interestingly, while heads and extremities are often categorized together as butchery waste, cattle-sized head bones are *not* over-represented in this sample (in fact, they are

*under*-represented by 6%), which suggest that head bones from these carcasses had their own *chaîne opératoire* and were being disposed of elsewhere.

In all other instances across the Hattuša samples, body zones are never under- or over-represented by more than 15-16%. Given our expectations for the potential presence of specialized provisioning systems at Hattuša (see above), it is interesting to note that in each of these four samples, there is never an extreme over- or under-abundance of forelimbs or hindlimbs. These are two meat-rich body zones that one might expect to see in excess if a specialized provisioning system was providing certain areas of the settlement with meat. On the other hand, in a location where centralized butchery was taking place (in preparation for distribution) to supply these areas, we would expect a dearth of such body parts (and an abundance of butchery waste). Instead, in all four Hattuša assemblages, including the Bronze Age assemblages at Kesikkaya Northwest, Kesikkaya South, and the Lower Town, South Area, forelimbs and hindlimbs appear in relatively “normal” proportions. Again, within this model, the one stand-out sample is the Hittite period sample at Lower Town, South Area, which has strong over-representation of extremities (i.e. butchery waste), but even within this sample, this pattern is not accompanied by a strong under-representation of meat-rich elements (i.e. consumption waste).

#### 5.5.2.2 Çadır Höyük Results

Karum period cattle-sized materials from Çadır were excluded from skeletal parts analysis due to sample size. Within the Hittite period sample from Çadır, many of the cattle-sized elements are represented fairly evenly (Fig. 5.21a). Elements from the extremity region have the highest representation (calcaneus and astragalus both have an MNE of 13) While the

MNE of phalanges is higher (first phalanx MNE=27), this relative representation of this element drops dramatically when the number of times it appears in the body is taken into account (first phalanx MAU=3.375). In terms of frequency, these extremity elements are followed closely by elements of the forelimb (proximal radius, distal radius, and proximal ulna all have an MNE of 12). The MNE of the best-represented hindlimb element, the proximal femur, is not much lower (MNE=10). When examined by MAU%, the Hittite period materials at Çadır display a relatively even distribution of body zones (Fig. 5.22a), with all parts of the carcass essentially equally represented. No body zone is notably over- or under-represented.

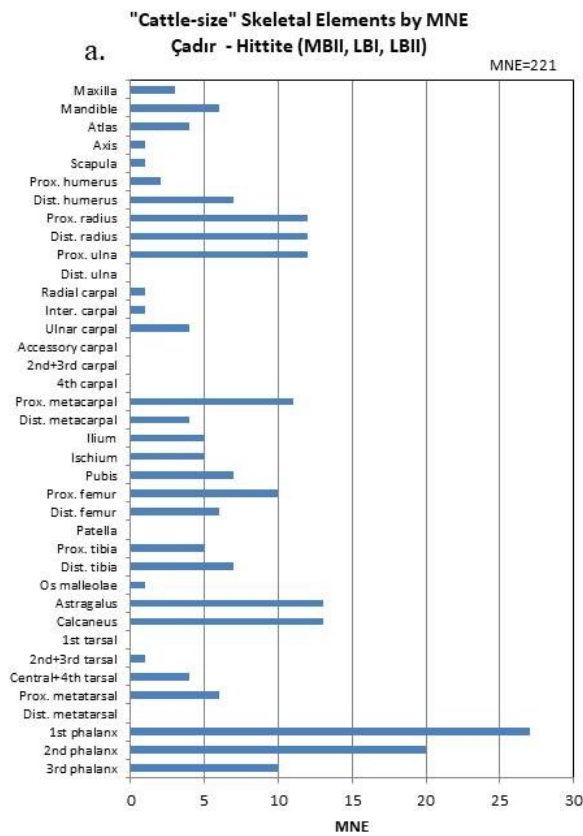


Figure 5.21 Çadır “cattle-size” elements by MNE (part 1)

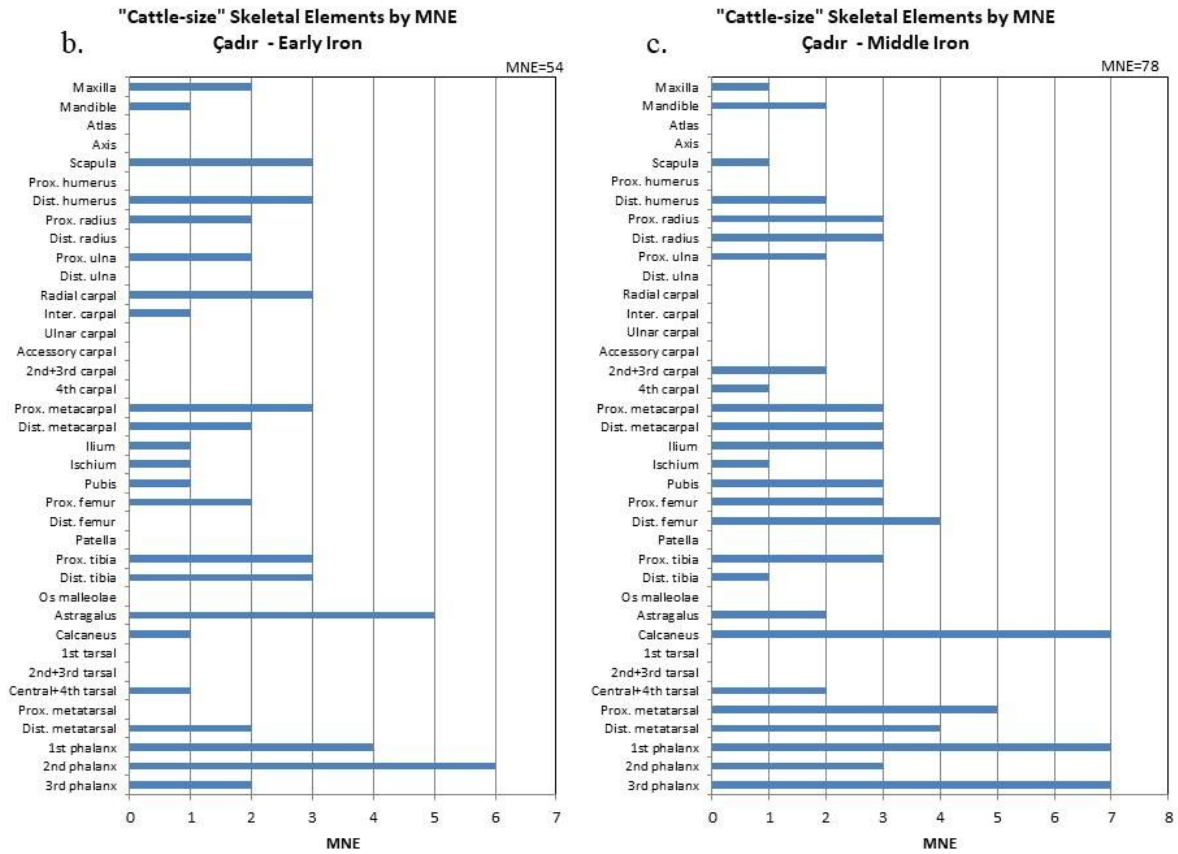


Figure 5.21 Çadır “cattle-size” elements by MNE (part 2)

Disregarding the over-abundance of second phalanges, the Early Iron skeletal element (Fig. 5.21b) with the highest frequency is the astragalus (MNE=5). It is followed in abundance by elements from the forelimb (scapula, distal humerus) and hindlimb (proximal tibia, distal tibia), each of which has an MNE of 3. The elements of the pelvis have a lower representation (ilium, ischium, and pubis; each has an MNE of 1), and the atlas and axis are completely absent. These patterns are echoed by the Early Iron body zone distribution calculated using MAU% (Fig. 5.22b). Extremities are over-represented by 19%, while the elements of the head, forelimb, and hindlimb are present in more “normal” percentages that hover around the “zero” axis of the

MAU%, neither over- nor under-represented. The pelvis and the axial skeleton, on the other hand, are under-represented (by around 10% and 16% respectively).

Disregarding the over-abundance of first and third phalanges (Fig. 5.21c) among the Middle Iron cattle-sized elements at Çadır, the calcaneus has the highest occurrence (MNE=7), followed by the proximal metatarsal (MNE=5). Outside of the extremity region, the element with the next greatest frequency is the distal humerus (MNE=4). As was the case during the Early Iron Age, the atlas and axis are not present. When examined by MAU% (Figure 5.22c), the extremity region is over-represented by 20%. The hindlimb is slightly over-represented (by 4%), and the forelimb and pelvis are present in roughly “normal” amounts (about 1% under-represented). The head is somewhat more under-represented (by 6%), and the axial skeleton is very under-represented (by 16%).

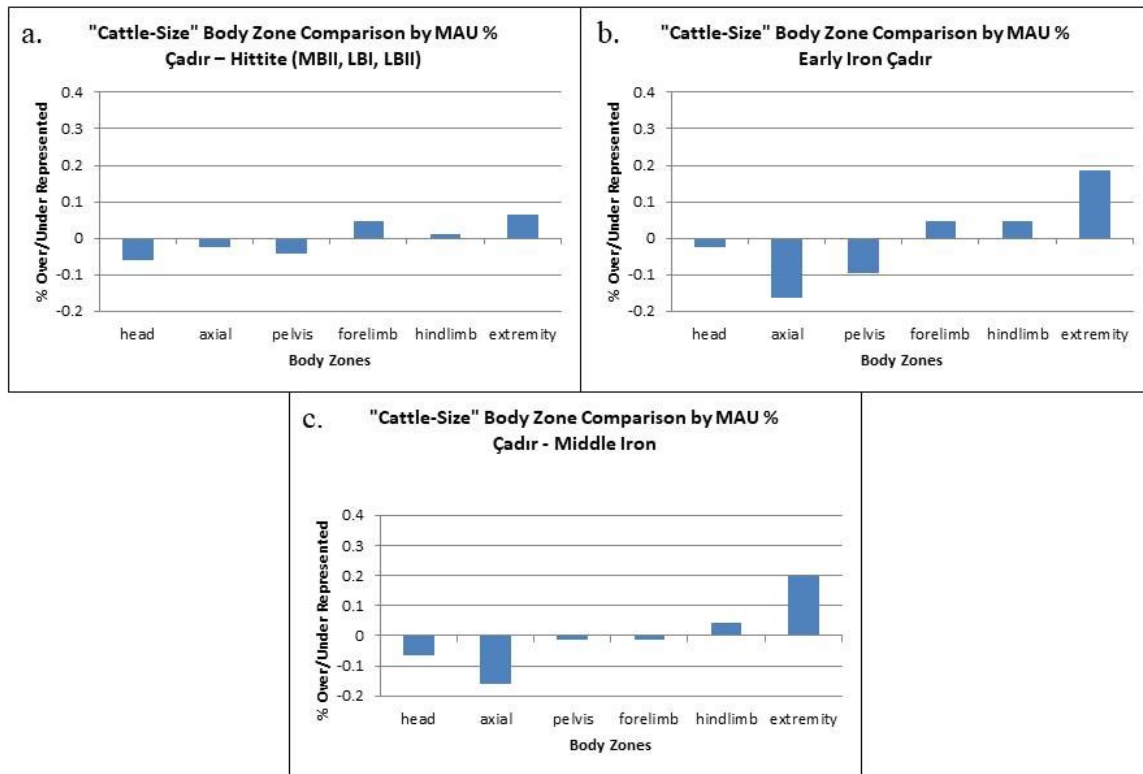


Figure 5.22 Çadır “cattle-size” body zone distributions by %MAU.

Within the Çadır cattle-sized assemblages, the Hittite period stands out due to its relatively flat body zone distribution. This distribution, with body zones typically interpreted as representing butchery waste in even proportion with those interpreted as consumption waste, reflects the general pattern one might expect to see if butchery and consumption activities were occurring in the same area. In contrast, in the Iron Age deposits, the cattle-sized body zones are much more unevenly distributed. At the same time, the two Iron Age distributions (Figs. 5.22b and 5.22c) are noticeably similar to one another. In both periods, the axial skeleton is largely absent, and extremities are extremely over-represented (by around 20%). Likewise, the relative proportions of forelimbs and hindlimbs in the Early and Middle Iron Age assemblages are quite

similar. In both periods, the distributions of these body zones stays relatively close to the “zero” axis. The most notable difference between the Early and Middle Iron body zone distributions relates to the pelvis. During the Early Iron age, there is an under-abundance of pelvic bones (10% under-represented). However, during the Middle Iron Age, the relative proportion of pelvic bones increases so that they are no longer under-represented. Given the frequent association between extremities and butchery waste, the strong over-representation of feet and ankle bones in the two Iron Age assemblages may be indicative of a trash deposit where butchery waste was disposed of.

### 5.5.2.3 Hattuša vs. Çadır Höyük “Cattle-Sized” Skeletal Parts Comparison

As discussed elsewhere, we might expect that as the Hittite capital, Hattuša would have complexly organized specialized provisioning system in place to supply the residents of this large city with meat during the Bronze Age. In terms of signatures, this would result in a spatial separation between butchery waste and consumption waste at the site. We do see this to some extent in the Hittite period samples from the Lower Town, South Area, and Kesikkaya South. In the Lower Town (Fig. 5.20b), there is an extremely strong over-representation of extremities, often associated with butchery waste. In contrast, at Kesikkaya South, there is a large-scale over-representation of cattle pelvises (Fig. 5.20c), the area of the body from which the meat-rich loin cuts derive. If we surmise that the Hittite collapse would have disrupted the animal economy at Hattuša, resulting in the breakdown of the settlement’s specialized provisioning system, we would expect to see a shift toward direct provisioning post-collapse. In other words, we might expect to see more even distributions of consumption and butchery waste, indicating that animals were no longer being butchered in specialized locations. During the Middle Iron Age at

Kesikkaya South (Fig. 5.20d), however, there is a disproportionately high amount of butchery waste (seen in the over-representation of extremities). Though not as extreme as what we see at Hittite Lower Town South, this pattern is not consistent with what we would expect for direct provisioning.

At Çadır, if Hittite political and economic organization involved a strong integration between Hattuša and rural centers (like Çadır), we would expect that there might be a shift away from specialized provisioning systems at the site after the Hittite collapse, since disruptions in the broader economic organization would affect capital and provincial sites alike. In contrast, if, as some collapse narratives imply, rural sites like Çadır had always led a fairly independent existence, largely unaffected by the political superstructure, then the collapse of the Hittite empire would have had minimal economic impacts at Çadır, and patterns of provisioning and consumption (whether specialized or not) would likely remain consistent at the site across the transition to the Iron Age.

At Çadır, there does appear to be a definite shift in the distribution of cattle-sized parts from the Hittite period into the Iron Age, which contradicts models suggesting that economic life at rural sites like Çadır would be unaffected by changes in the region's political superstructure. The Hittite period assemblage is characterized by a fairly even distribution of cattle-sized body parts, indicating that whole cattle carcasses were present. In terms of provisioning, this pattern suggests that animals were likely brought in on the hoof and that butchery and consumption activities were occurring in the same area. The fact that animals were being consumed where they were butchered implies that cattle meat was not being distributed through a specialized provisioning system at the site at this time. The strong over-representation of butchery waste (in the form of extremities) during the Iron Age at Çadır is suggestive of a shift in provisioning

practices, suggesting a new separation between butchery and consumption activities for cattle-sized animals. In essence, this change marks a potential shift from direct provisioning during the Hittite period to indirect provisioning post-collapse. The shift from direct to indirect provisioning of cattle-sized animals is especially interesting.

### 5.5.3 “Other” Taxa Skeletal Parts

#### 5.5.3.1 Hattuşa Results

##### Pigs

The Karum/Hittite Trans. pig sample at Kesikkaya Northwest consists of 89 specimens representing all areas of the body. The head (NISP=26) is represented by an assortment of skull specimens (NISP=9), the maxilla (NISP=5), the mandible (NISP=8), and a handful of loose teeth (NISP=4). The axial skeleton is represented by the axis (NISP=1). All elements of the forelimb (NISP=30) are present: the scapula (NISP=8), the humerus (NISP=9), the radius (NISP=5), and the ulna (NISP=8). The hindlimb (NISP=6) is represented by the femur (NISP=1) and the tibia (NISP=5). Specimens from the pelvis are present as well (NISP=4). The extremity (NISP=22) is represented by the astragalus (NISP=7), the calcaneus (NISP=6), other carpals/tarsals (NISP=1), metapodials (NISP=5), phalanges (NISP=3). To summarize, pig body zones within the Karum/Hittite Transitional sample at Kesikkaya Northwest have a fairly even distribution between head (NISP=26), forelimb (NISP=30), and extremity specimens (NISP=22). However, the frequency of extremity specimens may be misleading given how many of these elements appear in the body. The lower numbers of specimens from the pelvis and axial skeleton may relate to their low density.

The Hittite period pig sample from the Lower Town, South Area, consists of 39 specimens. Over half of these come from the head (NISP=21). The head elements present include various elements of the skull (NISP=4), the mandible (NISP=9), and loose teeth/teeth fragments (NISP=8). The forelimb is the second-most abundant body zone (NISP=10). These specimens include the scapula (NISP=2), the humerus (NISP=1), the radius (NISP=6), and the ulna (NISP=1). Hindlimb elements are present in the form of the femur (NISP=2) and the tibia (NISP=2). Elements of the extremity (metapodials, NISP=3) are very limited in appearance when one takes account the number of times elements from within this body zone are repeated in the body. Axial elements are rare (atlas, NISP=1), and elements from the pelvis are entirely absent.

The Hittite period pig sample from Kesikkaya South is relatively small (NISP=9). The forelimb is the most commonly represented body zone, represented by the humerus (NISP=3) and the radius (NISP=1). Elements from the head are the second-most common, represented by the maxilla (NISP=2) and a loose tooth (NISP=1). Other elements present include an atlas (NISP=1) and a metapodial (NISP=1).

The Middle Iron period pig sample from Kesikkaya South is larger (NISP=76). The head and the forelimb are by the most commonly represented body zones (for both, NISP=28). The head is represented by an assortment of skull elements (NISP=10), the maxilla (NISP=6), the mandible (NISP=8), and a handful of loose teeth/tooth fragments (NISP=4). The forelimb is represented by the scapula (NISP=6), the humerus (NISP=13), the radius (NISP=7), and the ulna (NISP=2). These body zones are followed in frequency by the extremity (NISP=10) and the hindlimb (NISP=8). The extremity is represented by the astragalus (NISP=2), the calcaneus (NISP=1), the metapodials (NISP=4), and the phalanges (NISP=3). The hindlimb is represented

by the femur (NISP=2) and the tibia (NISP=6). The axial skeleton and the pelvis are both poorly represented (for both, NISP=1).

In all four Bronze/Iron Age pig samples from Hattuša, heads and forelimbs are the two most frequently represented body zones. Additionally, across all four samples, specimens from the forelimb strongly outnumber those of the hindlimb. For example, at Karum/Hittite Transitional Kesikkaya Northwest, the ratio of forelimbs to hindlimbs is 5:1. The most “even” ratio comes from Hittite Lower Town, South Area, where the ratio of forelimbs to hindlimbs is still 2.5:1. This pattern of forelimbs heavily outnumbering hindlimbs, may be largely attributable to density, given that both ends of the femur, one of the two primary hindlimb bones, are less dense and do not always preserve well.

### Equids

Equid specimens from the Karum/Hittite Transitional Period at Kesikkaya Northwest (NISP=7) are represented by the scapula (NISP=2), the astragalus (NISP=1), and the calcaneus (NISP=4). No equid remains were present at Hittite period Lower Town, South Area. At Hittite period Kesikkaya South, equids are represented by the calcaneus (NISP=1) and a loose tooth (NISP=1). At Middle Iron Kesikkaya South, equids are represented by the metapodials (NISP=2) and loose teeth (NISP=5).

### Canids

Canid specimens from the Karum/Hittite Transitional Period at Kesikkaya Northwest (NISP=4) are represented by the radius (NISP=1), the pelvis (NISP=1), the tibia (NISP=1), and the calcaneus (NISP=1). At Lower Town, South Area, during the Hittite period, there is a single

canid specimen, an occipital bone. No canids were identified in the Hittite period Kesikkaya South assemblage. Canid specimens from the Middle Iron assemblage at Kesikkaya South (NISP=12) are represented by the head (NISP=5), the hindlimb (NISP=1), and the extremity (NISP=7). By element, these break down into maxilla (NISP=1), mandible (NISP=4), tibia (NISP=1), metapodial (NISP=1) and phalanx (NISP=1).

### Cervids

Deer specimens from the Karum/Hittite Transitional period at Kesikkaya Northwest (NISP=13) are entirely represented by the forelimb (NISP=5) and the extremity (NISP=8). These specimens break down as follows: scapula (NISP=2), radius (NISP=1), ulna (NISP=1), calcaneus (NISP=4), metapodial (NISP=2), phalanges (NISP=3). At Hittite period, Lower Town South, there is a single deer specimen, a first phalanx. At Hittite period Kesikkaya South, there is a single deer specimen, a metapodial. At Middle Iron Kesikkaya South (NISP=11), deer are represented by the forelimb (NISP=4) and the extremity (NISP=7). These specimens break down as follows: scapula (NISP=1), humerus (NISP=2), radius (NISP=1), metapodial (NISP=3), phalanges (NISP=4).

### 5.5.3.2 Çadır Höyük Results

#### Pigs

The pig sample for the Karum period at Çadır is small (NISP=12) and is represented by a limited number of skeletal parts from three body zones: the head (frontal, NISP=1; maxilla, NISP=2; mandible, NISP=1; loose teeth, NISP=3), the forelimb (scapula, NISP=1) and humerus (NISP=3), and the extremity (metapodial, NISP=1).

The Hittite sample is larger (NISP=161) and contains a wide array of elements representing all six body zones (head, axial, pelvis, forelimb, hindlimb, extremity). Specimens from the head (assorted skull specimens, NISP=10; maxilla, NISP=12; mandible, NISP=16, loose teeth/tooth fragments, NISP=37) are the most common, followed by those of the extremity (metapodial, NISP=25; astragalus, NISP=3; calcaneus, NISP=3; other carpals/tarsals, NISP=1; phalanges, NISP=14). However, it must be remembered that this high number of extremity elements would be distributed across the four sets of digits that pigs have on each of their four feet. Elements from the forelimb (scapula, NISP=11; humerus, NISP=7; radius, NISP=6; ulna, NISP=4) have the next highest frequency. Specimens from the hindlimb (femur, NISP=1; tibia, NISP=6) are not as well represented. The elements of the axial skeleton (atlas, NISP=4) and the pelvis (ilium, NISP=1) are the least common.

Because of the larger sample size, relative body zone representation was able to be examined using MAU%. When analyzed in this manner, elements from the head display the highest representation: 20% over-represented when calculated by MAU% (based on the mandible, MNE=11). The pelvis is the least represented: under-represented by 13% (based on the ilium, MNE=1). The hindlimb and extremity are somewhat under-represented (for both, MAU%= -7%; MNE=3, based on distal tibiae and proximal metapodials). The axial and forelimb zones are both slightly over-represented (MAU%=3% for both, using the atlas [MNE=3] and the scapula [MNE=6], respectively).

The Early Iron Age pig sample at Çadır is small (NISP=17) but contains specimens from all areas of the skeleton except for the pelvis and the axial skeleton. The head is represented by the temporal bone (NISP=1), maxilla (NISP=1), the mandible (NISP=2), and a handful of loose teeth/teeth fragments (NISP=5). The forelimb is represented by the radius (NISP=2), the

hindlimb by the fibula (NISP=1), and the extremity by the fourth metacarpal (NISP=1), the second metatarsal (NISP=1), the calcaneus (NISP=1), and the first phalanx (NISP=2).

The Middle Iron Age pig sample is larger (NISP=70). Specimens from this sample are dominated by the elements of the head (assorted skull elements, NISP=5; mandible, NISP=6; maxilla NISP=4; loose teeth/tooth fragments, NISP=22) and the extremity (metapodials, NISP=7; phalanges, NISP=11). Other elements present include the atlas (NISP=1), the ilium (NISP=1), the ischium (NISP=1), the scapula (NISP=3), the humerus (NISP=2), the radius (NISP=3), and the tibia (NISP=4).

For all four periods and spanning the Bronze/Iron transition, forelimbs are represented in greater quantities than hindlimbs, suggesting a consistent pattern in which the cuts of meat from the hindlimb were ending up outside of the excavation area. Simultaneously, within the Hittite and Middle Iron Age assemblages, where pig sample sizes tend to be larger, bones from the head appear with a very high frequency. These specimens could represent butchery waste, or given the low frequencies of elements from the low density body zones (axial skeleton and pelvis), this pattern could reflect density-mediated attrition. However, it seems likely that bone density alone is unlikely to account for the extreme nature of the pattern (20% over-representation of heads during the Hittite period based on MAU%).

### Equids

No equid remains were recovered from the Karum period at Çadır. The Hittite sample (NISP=11) included elements from the head (loose teeth, NISP=4), forelimb (radius, NISP=3), and the extremity region (carpal/tarsal, NISP=3; metapodial, NISP=1). The Early Iron sample

(NISP=6) included elements of the head (mandible, NISP=1), the axial skeleton (atlas, NISP=1), the forelimb (scapula, NISP=1), and the extremity (astragalus, NISP=2; tarsal=1).

During the Middle Iron Age, equids appear in relatively larger quantities (NISP=52), and all body zones are present with the exception of the axial skeleton. The head is represented by a single maxillary fragment (NISP=1) and a variety of loose teeth (NISP=16). The pelvis is represented by three ilium and ischium fragments (NISP=3). The specimens of the forelimb consist of humerii (NISP=2), scapulae (NISP=2), and a radius (NISP=1). The hindlimb is represented by femorae (NISP=2) and a tibia (NISP=1). Finally, the extremity samples consist of metapodials (NISP=5), astragali (NISP=2), calcanei (NISP=3), other carpals/tarsals (NISP=5), sesamoids (NISP=2), and phalanges (NISP=7).

### Canids

The vast majority of the Karum period canid specimens at Çadır appear to derive from a nearly complete neonate skeleton. One other canid specimen (an adult incisor) was identified among the animal remains of this period. The Hittite period has a relatively high incidence of canid specimens (NISP=43). These specimens represent all parts of the body except for the pelvis. The head is represented by the maxilla (NISP=1), the mandible (NISP=7), and a handful of loose teeth (NISP=5), and the axial skeleton is represented by the atlas (NISP=2) and the axis (NISP=1). Bones from the forelimb appear with some frequency (scapula, NISP=3; humerus, NISP=3; radius, NISP=2; ulna NISP=3), while the representation of the hindlimb is limited to a single femur specimen (NISP=1). The extremity region has the highest count (NISP=15). This category is comprised of metapodials (NISP=9), an astragalus (NISP=1), a calcaneus (NISP=1), a radial+intermediate carpal (NISP=1), and several first phalanges (NISP=3).

The range of canid specimens in the Iron Age is much more limited. During the Early Iron Age, recovered canid specimens consist of mandibles (NISP=2), a loose tooth (NISP=1), and a fifth metacarpal (NISP=1). During the Middle Iron Age, recovered canid specimens consist of a maxilla specimen (NISP=1), five loose teeth (NISP=5) and two limb specimens (humerus, NISP=1; tibia, NISP=1).

### Cervids

A total of eight cervid specimens were identified in the Middle to Late Bronze and Early to Middle Iron Age assemblages at Çadır. Two cervid specimens (NISP=2) were identified among the Hittite period specimens, a metapodial fragment and a tooth fragment, both dating to the Late Bronze II. The Early Iron Age excavations also yielded a single cervid specimen (NISP=1), an antler possibly belonging to *Dama dama*. The Middle Iron Age assemblage yielded a handful of specimens, representing the head (antler, NISP=2; two loose teeth, NISP=2), pelvis (ilium, NISP=1), and extremity (first phalanx, NISP=1).

While the overall number of cervid specimens is small, it is worth noting that with a single exception (the ilium fragment from the Middle Iron Age sample), all cervid specimens from Çadır come from areas of the body often categorized by zooarchaeologists as butchery waste (i.e. heads and extremities). However, given the utility of antler as a material for tool production, it is possible that the antler specimens may have been collected separately (as shed antler) as blanks for future tool production, and they may not represent butchery waste.

### 5.5.3.3 Hattuşa vs. Çadır Höyük “Other” Skeletal Part Comparison

Within both the Hattuşa and Çadır pig assemblages forelimb specimens outnumber those of the hindlimb in every sample included here, spanning the Middle/Late Bronze and Iron Ages. Across all four Hattuşa samples, specimens from the head region and the forelimb dominate, and the same is true of the two larger pig samples (from the Hittite period and the Middle Iron Age) at Çadır. As noted above, this pattern is likely due to the density of these skeletal elements in pigs. The over-representation of the head could also relate to how easily identifiable elements of the pig skull are relative to those of other taxa (cf. Rossel 2007).

The most notable pattern that appears when comparing the “other” taxa between Hattuşa and Çadır is the differences in cervid skeletal part distributions between the two sites. At Hattuşa, forelimb and extremity specimens dominate the Middle to Late Bronze and Middle Iron assemblages. (During the Hittite period, deer specimens in these assemblages are limited to two extremity specimens.) However, at Çadır, with a single exception (an ilium fragment from the Middle Iron Age), all Bronze and Iron Age deer specimens come from either the head or the extremity region, both areas often associated with butchery waste. The pattern at Hattuşa, which consists of a single meat-rich body part and extremities, combined with the prominence of the site in the region, and the association between deer hunting and elites in the ancient Near East (Allsen 2006) is likely indicative of hunting activities by local elites. The pattern at Çadır, where deer are only present in the form of head elements and extremities, rather than in the form of meat-rich elements intended for consumption, is suggestive of different practices associated with the use of deer and their remains. Clearly, the “meaty” parts of these cervids ended up outside excavation areas at the site. It is possible that the heads and extremities present in the areas that have been excavated represent skins.

**CHAPTER 6**  
**SUMMARY: THE ZOOARCHAEOLOGY OF THE HITTITE**  
**COLLAPSE AND ITS AFTERMATH**

This chapter provides a summary of the results presented in the preceding chapter, which are then placed within the broader context of central Anatolia before and after the Hittite collapse in the chapter that follows. This chapter begins with a summary of the results of the Hattuša samples from Karum/Hittite Transitional period Kesikkaya Northwest; Hittite period Lower Town, South Area; and Hittite and Middle Iron Age Kesikkaya South. Results are organized by the three primary taxa (i.e. cattle, caprines, pigs), each of which is broken down by form of analysis (i.e. relative frequencies, survivorship/mortality, biometrics, skeletal parts). Each subsection begins with a brief review of the anticipated results before and after the Hittite collapse (the interpretive framework introduced in Chapter 4), and the results are then presented with an eye toward whether or not they align with expectations. This discussion is then repeated for the results from Çadır Höyük before and after the Hittite collapse.

After the results of the analyses are summarized, the scope of discussion broadens to the site-wide level at Hattuša. In this section, the results from Kesikkaya Northwest, Kesikkaya South, and the Lower Town, South Area are put into dialogue with published data from other parts of Hattuša, including Büyükkaya (von den Driesch and Pöllath 2004), the Middle Plateau (Berthon 2017), Sarıkale (Hollstein and Meddea 2014), and the earlier excavations at the Lower Town (von den Driesch and Boessneck 1981), in order to give a broader sense of the organization of animal economies at the site before and after the Hittite collapse.

## 6.1 Hattuša

### 6.1.1 Cattle

#### Frequencies

As discussed above (Table 4.1), we might expect that during the Hittite period, there would be a relative abundance of cattle at Hattuša given the association between cattle and wealth in the ancient world. As a corollary to this, we might expect that the frequency of cattle would decrease at Hattuša after the collapse of the Hittite empire, when, due to economic disruption in the region, resources were no longer available to maintain these large animals.

What we see in the archaeological record does not fully align with these expectations. The frequency of cattle in the Karum/Hittite Transitional period and Hittite period samples is low to moderate: 13.2% at Karum/Hittite Kesikkaya Northwest, 5.3% at Hittite Kesikkaya South, and 18.5% at Hittite Lower Town, South Area based on %NISP (Fig. 5.1a). These percentages are much lower than the Karum/Hittite Transitional period and Hittite period caprines, which range between approx. 65% and 80% based on %NISP. Interestingly, these cattle frequencies from Bronze Age Hattuša are also lower than the cattle frequencies at Çadır Höyük during the Hittite period, a circumstance which will be discussed further depth below. Moreover, the cattle frequency at Middle Iron Age Kesikkaya South (%NISP=18.6%) marks an increase in the proportion of cattle from the same area of the site during the Hittite period (rather than a decrease as expected), and is on par with the percentage of cattle present during the Hittite period at the Lower Town, South Area.

### Survivorship/Mortality

In Chapter 4, we discussed how expectations for cattle kill-off at Hattuša might entail an abundance of adult animals given the use of cattle for traction, but that, given the given the long-standing association between cattle and elites in Bronze Age Anatolia (Arbuckle 2014b) and the wealth of the Hittite capital, we might expect to see a higher consumption of younger cattle at Hattuša during the Hittite period and a shift away from this kind of consumption after the Hittite collapse.

The results (Fig. 5.7) show that while, during the Karum/Hittite Transitional period at Kesikkaya Northwest, only about 55% of cattle reached the age of 42-48 months (when the latest fusing cattle long bones fuse). This result suggests that the meat of younger cattle (between the ages of 3-4 years) was being consumed at Kesikkaya Northwest during this time. In contrast, the vast majority of cattle at Hittite period Lower Town, South Area, survived to the age of at least 42-48 months, indicating that very few animals were being killed off earlier in life in this Hittite sample. Across the Bronze/Iron transition, there is little change, with the majority of animals in the Middle Iron Age sample at Kesikkaya South reaching the age of 42-48 months at a minimum. Thus, in both the Hittite period sample from Lower Town, South Area, we see cattle being kept well into adulthood, likely for traction and dairy use, which is not in keeping with the expectation of a preference for younger cattle meat during the Hittite period.

### Biometrics

As discussed elsewhere (Figs. 4.4), our expectation was that, during the Hittite period at Hattuša, cattle might have an overall larger body size and that, post-collapse, overall body size might decrease due to the introduction of less “improved” breeds. Moreover, we expected that, in

terms of production during the Hittite period, size distributions would show an abundance of both larger bodied, “male-sized” cattle and smaller bodied, “female-sized” cattle, with the anticipation that male animals and oxen would be used for agricultural purposes around the site. We expected that, during the Iron Age, with the empire’s collapse, priorities might shift, and the focus might turn primarily to female animals that could be used as an “all-purpose” investment: for breeding, dairy, and traction. If this were the case, we would expect the proportion of large-bodied “male-sized” animals to decrease during the Iron Age.

During the Karum/Hittite transitional period at Kesikkaya Northwest (Fig. 5.13a), the majority of the animals appear to be smaller bodied/likely female (with LSI values ranging from approx. -0.06 to 0.04, clustering around a mode of approx. 0.01). A smaller number of larger-bodied/likely male animals is represented by the cluster of specimens with LSI values ranging from 0.04 to 0.08. This distribution represents a herd structure where a small number of males is allowed to reach adulthood, either for traction or for breeding, and the majority of the herd is comprised of adult females (for traction/breeding/dairy production).

In contrast, the cattle LSI value distribution at the Hittite Lower Town, South Area (Fig. 5.13b), suggests that this sample is made up of almost entirely female animals. In this distribution, specimens with LSI values above 0.03 (those that fall into the larger-bodied/male-sized category at Karum/Hittite Kesikkaya Northwest) are almost entirely absent. However, the mode of the distribution (0.025) is fairly close to the modes for the “adult female-sized” distributions at Kesikkaya Northwest, Karum/Hittite Transitional, and Kesikkaya South, Middle Iron (discussed below). Its range is also roughly in keeping with the “adult female-sized” distributions from these samples. Assuming there is no major size difference in the cattle populations across these three samples, these similarities suggest that the vast majority of the

cattle specimens in the Hittite Lower Town, South Area may belong to female cattle and that male cattle were mostly absent from this area of the site during the Hittite period (or at least were not being consumed/disposed of there during this time).

The cattle size distribution from Kesikkaya South during the Middle Iron Age (Figure 5.13c) is very similar to that of the Karum/Hittite Transitional sample from Kesikkaya Northwest: a small proportion of larger-bodied, likely male animals ranging from around 0.04 to 0.09 and a larger proportion of smaller-bodied, likely female animals ranging from around -0.04 to 0.04. Again, this distribution may be interpreted as representing a herd structure where only a relatively small number of males is allowed to reach adulthood and a large number of females are maintained for a variety of purposes (breeding, dairy, traction). The main difference here appears to be an increase in the number of smaller, likely subadult animals in the sample (represented by the handful of specimens with smaller LSI values trailing off to the left in Figure 5.13c).

To summarize, the expectation that a large number of larger, male-sized animals would be identified in the Hittite period at Hattuša (for use in intensive agricultural production) was not met. As expected, we do see a high proportion of smaller, female-sized cattle relative to larger, male-sized cattle in the Middle Iron Age assemblage at Kesikkaya South, which is a pattern associated with “smaller-scale” economies (cf. Isaakidou 2011; Isaakidou 2006). However, this pattern is also visible at Kesikkaya Northwest during the Karum/Hittite Transitional period (Middle Bronze Age). In addition, contrary to expectations, there is no decrease in cattle body size range in the Middle Iron sample from Kesikkaya South.

### Skeletal Parts

Our expectations for skeletal parts distributions at Hattuša during the Hittite period, rests on the assumption that, following Zeder (1991), as a large urban center, the Hittite capital would need a specialized provisioning system in order to distribute animal resources, and that the presence of such a system would result in the spatial separation of butchery and consumption activities and associated waste. Thus, during the Hittite period at Hattuša, we would expect to see the spatial separation of butchery and consumption waste (Table 4.7). Moving into the Iron Age, when such specialized economic systems might be disrupted as a result of the empire's collapse, we might expect to see a shift in spatial patterning such that butchery and consumption waste begin to appear in the same locations. This type of pattern would suggest that local consumers were either raising animals themselves or obtaining them directly from producers and butchering the animals themselves rather than, for example, obtaining cuts of meat from a butcher.

During the Karum/Hittite Transitional period at Kesikkaya Northwest, no cattle skeletal part is extremely over- or under- represented (Fig. 5.20a). However, heads and axial elements *are* somewhat under-represented (by approximately 12% and 6% respectively), and pelvises and hindlimbs are somewhat over-represented (by around 9% and 6% respectively). These results suggest a degree of spatial separation between butchery and consumption, but it is not highly pronounced. During the Hittite period at the Lower Town, South Area (Fig. 5.20b), on the other hand, there is, most notably, an extremely strong over-representation of extremities (by 30%), suggesting that this sample is representative of discarded butchery waste and the spatial separation of butchery and consumption activities. The Hittite period sample at Kesikkaya South (Fig. 5.20c) is notable for its over-representation of pelvis bones (by nearly 20%), a meat rich body part indicative of consumption waste. Moving into the Iron Age, the Middle Iron Age

sample at Kesikkaya South displays an over-representation of extremities (by approximately 15%) as well as the under-representation of head elements (by approximately 10%). (As discussed in Chapter 5, the under-representation of axial elements in this and the other samples is likely related to density.) These results again toward different patterns of deposition for different skeletal parts at Middle Iron Kesikkaya South, suggesting the butchery and consumption were taking place in different areas.

Consistent with expectations, the spatial separation of butchery and consumption waste at Hittite Hattuša (Kesikkaya South, and Lower Town, South Area) suggests that there was a specialized provisioning system present at the site during the Hittite period. Interestingly, the two Hittite period samples have the highest degree of over/under-representation in skeletal parts (measured by the distance from the ‘zero’ axis in Fig. 5.20). The results also suggest that provisioning of cattle meat was taking place at the site earlier in the Bronze Age (during the Karum/Hittite Transitional period at Kesikkaya Northwest) and later during the Middle Iron Age (at Kesikkaya South), but that there may have been a difference in degree/intensity. While specialized provisioning does seem to have been still taking place at Hattuša the degree of over/under-representation of skeletal parts is less than in the Hittite period samples.

### *6.1.2 Caprines*

#### *Frequencies*

Our expectation for caprines at Hattuša during the Hittite period (Table 4.1) was that there would be a high ratio of sheep to goats during this time given the role of wool production in regional trade in Anatolia during the Bronze Age (Arbuckle 2012). Moreover, we expected that with the collapse of the Hittite empire and a potential shift toward herd security rather than

commodity production (discussed in Chapter 4 and below) the ratio of sheep to goats would decrease (i.e. there would be an increase in the relative proportion of goats).

During the Karum/Hittite Transitional period, caprines are well-represented (%NISP=66.7%) with a high sheep to goat ratio of 3:1 (Figure 5.1a; Table 5.16). Results are similar for Lower Town, South Area during the Hittite period. During this time caprines are likewise well-represented (%NISP=72.6%), also with a sheep to goat ratio of 3:1. A sheep to goat ratio could not be calculated for Hittite period Kesikkaya South due to sample size, but within this sample, caprines are by far the most abundant type of animal (%NISP=80.7%). By the Middle Iron Age at Kesikkaya South, caprine species frequencies have decreased precipitously (%NISP=60.7%). Though this is still a strong degree of representation for caprines, this frequency is 20% lower than their representation in the same area of the site during the Hittite period. This decrease in caprine percentage at Middle Iron Kesikkaya South is accompanied by a lower sheep to goat ratio of 2:1.

To summarize, as expected, we do see a high sheep to goat ratio in the Hittite period assemblage from the Lower Town, South Area (3:1). The same is true for the earlier Karum/Hittite Transitional materials from Kesikkaya Northwest (3:1). These sheep to goat ratios point toward the possibility of intensive wool production at the site during the Bronze Age. The Middle Iron Age sheep to goat ratio at Kesikkaya South is lower (2:1), possibly indicating the reorganization of caprine production priorities during the Iron Age at the site given the general association of goats with smaller scale production/herd security models of production.

### Survivorship/Mortality

Our expectations for caprine survivorship/mortality vary depending on whether the results are interpreted through the lens of production or provisioning (Tables 4.2 and 4.3). At Hattuša, our expectation was that, if intensive wool production was taking place at the site during the Hittite period (mentioned in the frequencies sub-section above), kill-off would take place late in life, as both female and male animals (particularly castrates) would be maintained well into adulthood for wool production (Table 4.2). We anticipated that, following the Hittite collapse, this pattern of survivorship might change, with fewer animals being maintained into old age. This pattern would be the signature of shifts toward more generalized production strategies that emphasize herd security over commodity production and minimize risk in terms of the herd structure (following the general models outlined by Payne 1973). We anticipated this would be the response to potential economic disruption at Hattuša post-collapse.

Following Zeder (1991) and Stein (1987), we anticipated that Hattuša likely had a specialized provisioning system in place to provide meat to residents, particularly during the Hittite period when the city's urban development was at its height (Table 4.3). In terms of caprine age distributions, we anticipated that if a specialized provisioning system was in place that we might see an abundance of market-aged/prime meat weight animals (2-3 years old) at the site, supplied by rural producers. Alternatively, however, depending on the relations between rural producers and the capital, we anticipated the possibility that rural producers might send much older, worn out animals (no longer useful for wool production/breeding) for consumption by urban consumers. If this were the case, the mortality signature would entail an abundance of older animals, and few younger ones. Interestingly, this signature is quite similar to the age profile one would anticipate for wool production, described in the preceding paragraph. Post-

collapse, we might expect this provisioning system at the site to break down. If this were the case, and animals were not being supplied to markets, we would expect that local consumers might begin managing their own herds, resulting in a much wider distribution of age categories.

During the Karum/Hittite Transitional period at Kesikkaya Northwest, caprine kill-off occurs quite late, peaking between three and six years (Payne's wear stages F and G) (Fig. 5.3b). Combined with the high sheep:goat ratio in this sample (discussed above) and the abundance of large-bodied (male-sized) animals in this assemblage (discussed in the biometrics section below), this age distribution aligns well with what one would expect to see associated with intensive wool production. The distribution for the Hittite period sample at the Lower Town, South Area, is strongly focused on prime meat weight animals (aged 2 to 3 years, Payne's wear stage D), with a smaller number of older animals (Fig. 5.3c) relative to the sample from Kesikkaya Northwest. This pattern points toward the provisioning of market-aged caprines in this part of the Lower Town during the Hittite period, which is consistent with the expectation that there might be evidence for specialized provisioning at the site during the Hittite period. Kill-off during the Middle Iron Age at Kesikkaya South (Fig. 5.3d) tends to be later, with kill-off peaking between three and six years (Payne's wear stages F and G). This distribution, which is fairly similar to the one from the Karum/Hittite Transitional period at Kesikkaya Northwest, points toward possible fiber production, but the decreased sheep to goat ratio in this sample (2:1) relative to the Karum/Hittite Transitional sample from Kesikkaya Northwest (3:1) does suggest the possibility of some kind of shift in the organization of production. On other hand, this signature may also represent the kind of provisioning system described above, where older animals once used to produce secondary products are brought to market.

### Biometrics: Sheep

As noted in Chapter 4, as well as in the preceding sub-section, we anticipated that there would likely be an emphasis on the production of secondary products, particularly fiber, at Hattuša during the Hittite period, and we have discussed how the commodity production of wool results in more male sheep killed later than in other production strategies (i.e. for meat, dairy) (Payne 1973). During the Hittite period at Hattuša we might expect that, if as has been discussed previously, there was an emphasis on the production of secondary products, particularly fiber, that most male sheep (particularly castrated males) would not be culled until later in life in order to maximize wool production (Table 4.4). Thus, in terms of biometric results, we would expect to see a higher than usual proportion of larger-bodied animals representing male sheep.

After the Hittite collapse, with the expectation of a decreasing emphasis on intensive commodity production, we would anticipate to seeing a shift toward a more low-risk sheep management strategy that prioritizes herd security. This kind of strategy would result in a different distribution of body sizes, with a lower proportion of large males relative to smaller females and younger animals (Redding 1984).

The body size of the sheep in the Karum/Hittite Transitional period sample at Hattuša Kesikkaya Northwest is very large, appearing to mostly represent mostly large adult males (specimens with LSI values ranging from approximately 0.0 to 0.08, larger than the size of the standard animal, a wild female sheep) (Fig. 5.9a). This pattern is in keeping with the classic intensive wool production pattern described by Redding (1984), where adult male castrates are kept in the herd for wool production until wool quality declines in old age and they are killed off for meat. The distribution here, combined with the caprine age data that show late kill-off for

individuals in this sample (discussed above), could be a sign that intensive wool production was taking place at Kesikkaya Northwest during the Middle Bronze Age.

The Hittite sheep sample from the Lower Town, South Area (Fig. 5.9b), also appears to be dominated by large bodied adult males (with LSI values also ranging from approximately 0.0 to 0.08). However, this sample does have more smaller-bodied (presumably female) animals (which extend toward the left side of Fig. 5.9b). The relatively high proportion of large bodied (presumably) adult male animals may represent an emphasis on secondary product production, particularly wool. When we look back at the caprine mortality data for this sample, there is a peak in kill-off between the age of two to three years, when caprines typically reach prime meat weight, and a second smaller peak in kill-off between four to eight years (Fig. 5.3c). This suggests the presence of (likely male) animals that have been killed off after they reach their full size and the maintenance of some animals until later in age, presumably for wool production. The LSI distribution, which includes some very large, presumably male, animals and smaller females, could be reflective of these combined production/provisioning strategies.

More than the two Bronze Age sheep distributions from Hattuša, this sample from Middle Iron Kesikkaya South seems to contain a larger, more visible cluster of smaller (presumably female) animals (with LSI values ranging from around -0.08 to -0.015) (Fig. 5.9c). However, the distribution is still skewed toward the larger, likely older male, animals (toward the right side of the distribution). Once again, this may be indicative of a production strategy focused on wool production, where older male animals are kept in the herd longer than they might be otherwise. This possibility is supported by the shape of the caprine mortality histogram for Middle Iron Kesikkaya South (Fig. 5.3d), where kill-off peaks relatively late in life, between three to six years.

The biometric results, combined with the survivorship results, from Hittite Lower Town, South Area, align with our expectations described above given that they offer potential evidence for the production of secondary products at the site during the Hittite period, as well as the presence of specialized provisioning. While large males remain abundant during the Middle Iron Age at Kesikkaya South, the increased proportion of female animals may indicate changes in production strategies, toward a decreased emphasis on wool, which is also supported by the lower sheep:goat ratio (2:1) at Kesikkaya South during this time.

### *Biometrics: Goats*

It has been argued that goat herd structure tended to be fairly stable in the ancient Near East, with herds consisting mostly of females (used for dairy/breeding) with a few males kept for breeding (Zeder 2008). For this reason, we anticipated to find this type of herd structure (mostly females, a small number of males) reflected in the biometric distributions of the Hattuša samples, during both the Bronze and Iron Ages.

Results from the Karum/Hittite Transitional period at Kesikkaya Northwest were as expected, with an LSI distribution that skews heavily smaller/female-sized and a handful of specimens with much larger/male-sized LSI values (Fig. 5.11a). (The Hittite period Lower Town, South Area materials were excluded due to sample size.) Curiously, the shape of the LSI distribution for the Middle Iron sample from Kesikkaya South (5.11b) is essentially the inverse of the expected distribution, with mostly larger-bodied adult males and a few smaller-bodied females. This distribution could represent the off-take of adult males no longer used for breeding, or it may point toward the use of male goats for hair production at the site during the Middle Iron Age.

### Skeletal Parts

Expectations for pre- and post-collapse caprine skeletal parts distributions at Hattuša are the same as those described above for cattle. Essentially, we expected that pre-collapse there should be evidence for the separation of butchery and consumption activities (i.e. indirect provisioning) and that post-collapse there might be increasing evidence for butchery and consumption activities occurring together (i.e. direct provisioning).

At Kesikkaya Northwest during the Karum/Hittite Transitional period and at the Lower Town, South Area during the Hittite period, body zones are not over- or under-represented to a strong degree (all skeletal parts fall within 6% of the '0' axis in Fig. 5.16). Given these relatively even distributions of skeletal parts, it is likely that the animals represented in these samples were butchered and consumed in the same area, which is a departure from expectations. At Kesikkaya South during the Hittite period, however, forelimbs and particularly pelvises are more strongly over-represented (by 8% and 12% respectively), pointing toward the separation of butchery and consumption activities. This is interesting given that we see differing outcomes in two different parts of the site during the same period.

During the Middle Iron Age at Kesikkaya South, the skeletal parts distribution is somewhat more even. The skeletal part with the highest degree of over- or under-representation is the pelvis (under-represented by 8%) but all other parts fall closer to an even distribution. This may point toward butchery and consumption activities taking place together, which is consistent with expectations for the Iron Age at the site.

### 6.1.3 Pigs

#### Frequencies

We have previously discussed how pigs can sometimes be interpreted as markers of economic decentralization due to their innate qualities (e.g. physiology, reproductive patterns) which lend themselves to small-scale, informal production (Zeder 2003; Grigson 2010). Presuming a high degree of economic centralization at Hattuša during the Hittite period, accompanied by the possibility of cultural restrictions on the consumption of pig meat (Collins 2006), we anticipated that the relative proportion of pigs at the site during this time would be low. We expected that post-collapse, as the formalized economy of the Hittite period experienced disruptions, that the proportion of pigs at the site might increase.

During the Karum/Hittite Transitional period at Kesikkaya Northwest, there is a fairly substantial proportion of pigs (%NISP=13%). (Fig. 5.1a). The proportion of pigs during the Hittite period at the Lower Town, South Area, and Kesikkaya South is lower (%NISP=8% and 5% respectively). During the Middle Iron Age at Kesikkaya South, the frequency of pigs is once again higher (%NISP=13%), which is more than double the proportion of pigs that appeared in this area of the site during the Hittite period. Thus, we do see relatively low proportions of pigs in the Hittite period samples, and a higher proportion of pigs at Middle Iron Age Kesikkaya South.

#### Skeletal Parts

Given the association between pigs and informal economies, it was anticipated that pig meat would not be part of specialized provisioning systems that might be in place at Hattuša and that both Bronze and Iron Age samples would show evidence for butchery and consumption

activities occurring together (i.e. that skeletal parts associated with butchery waste would appear together with skeletal parts associated with consumption waste). Across all samples (Bronze and Iron Age alike), heads and forelimbs were by far the most abundant pig skeletal parts (see Chapter 5). The abundance of these elements (and the relative absence of hindlimbs, the axial skeleton, pelvises, and extremities) was interpreted as the result of density-mediated attrition, as the “missing” skeletal parts tend to have relatively less dense elements. Identifiability may also be at play, since several of the skull elements of pigs are both very dense and easy for zooarchaeologists to identify (Rossel 2007).

## **6.2 Çadır Höyük**

### *6.2.1 Cattle*

#### *Frequencies*

As discussed previously, expected outcomes for Çadır vary depending on how we envision the relationship between smaller rural sites and the Hittite economic system. If we imagine a strong degree of political and economic integration in the Hittite period, we might expect species frequency signatures at rural sites like Çadır to echo those from the capital (discussed above and in Chapter 4) (Table 4.1a). In the case of cattle frequencies we might expect a relative abundance of cattle at the site, perhaps consumed by local elites. Subsequently, we would expect this frequency to decrease post-collapse due to economic disruption and given the large amount of resources cattle require.

Alternatively (Table 4.1b), if we imagine that rural sites like Çadır were largely economically independent from the Hittite economic superstructure, we would expect that, during the Hittite period, there might be a relatively low frequency of cattle due to the expense

they require to be maintained in large numbers. This model assumes that rural sites would be largely unaffected by the Hittite collapse, so we would expect to see this low cattle frequency continue into the Early Iron Age.

Cattle frequencies at Çadır during the Bronze Age are relatively high (Karum %NISP=31.8%; Old Hittite %NISP=26.2%; Middle Hittite %NISP=28.3%), peaking in the Hittite Empire/Transitional period (%NISP=38.2%). After the collapse of the Hittite empire, there is a clear decrease in the frequency of cattle at the site (Early Iron %NISP=19.0%; Middle Iron=16.1%). These findings are most consistent what we would expect to see if Çadır were economically intertwined with the broader Hittite economic system.

#### *Survivorship/Mortality*

As discussed in Chapter 4, given the value of the secondary products (dairy, traction) provided by cattle, we expected that generally speaking most of the cattle recovered at Çadır would be adults. However, we expected that we might see some consumption of younger cattle at Hittite Hattuša given the association between cattle and elites in Bronze Age Anatolia (Arbuckle 2014b). If this were the case at Hattuša, and we imagine that the economy at Çadır was well-integrated with that of the capital, we might expect to see some consumption of younger cattle at Çadır during the Hittite period as well. After the Hittite collapse, we would expect the consumption of younger cattle to decrease, as the animals' value for secondary products production would likely be prioritized over meat. If, on the other hand, rural sites like Çadır were not well-integrated into the broader Hittite economic structure, we might expect to see mainly older cattle at the site during the Hittite period, and we would expect to see a continuity in this pattern post-collapse.

Cattle epiphyseal fusion results from Çadır (Fig. 5.8) show that during the Hittite period at the site, less than half of the specimens in the final fusion stage (42-48 months) are fused, suggesting that over half of the cattle in the sample were killed off before reaching this stage. This is in contrast to the Early and Middle Iron Ages, when a higher percentage of cattle bones are fused in most age stages. These results go against the expectations of the non-integration model, which assumes that cattle kill-off should occur late in life both pre- and post-collapse.

### Biometrics

Regarding cattle body size at Çadır, our expectation was that, assuming a model of economic integration between rural sites and the Hittite state more broadly, cattle body sizes during the Hittite period would reflect the same pattern we expected to see at Hattuša: an abundance of both larger bodied, “male-sized” cattle (assuming male cattle/oxen would be used for traction) and smaller bodied, “female-sized” cattle (used for dairy/breeding) (Table 4.4a). Post-collapse, we expected to see a potential shift in cattle size toward mostly smaller, female-sized animals which could be used as a multi-purpose investment, thereby maximizing resources (Table 4.4b). We might also expect a decrease in overall body size, that might accompany a shift in nutrition levels or changes in cattle breeds. In contrast, assuming a model where rural economies were not well-integrated with those of the Hittite empire more broadly, we assumed that the more conservative, female-dominated cattle herd model would appear at Çadır during the Hittite period, and that this would continue across the Bronze/Iron transition.

The overall size ranges of Hittite period and Early/Middle Iron Age cattle at Çadır are largely consistent (Fig. 5.14), with LSI values ranging from roughly -0.04 to 0.10. (Larger specimens may represent aurochs and smaller specimens may represent younger animals.)

Generally speaking, both samples are dominated by a high proportion of smaller-bodied, likely female-sized animals (with LSI values ranging from approximately -0.04 to 0.04). In both cases, there is a smaller proportion of larger-bodied, likely male-sized animals (ranging from approximately 0.04 or 0.06 to 0.10). These results show a strong degree in continuity in size range as well as the relative proportions of female vs. male cattle over time, which fits well with the expectations associated with the non-integration model.

### *Skeletal Parts*

Assuming there was a strong degree of economic integration between rural sites and the Hittite state more broadly, it was anticipated that skeletal parts distributions at Çadır during the Hittite period might show evidence for specialized provisioning systems, resulting in the spatial separation of butchery and consumption waste, similar to what we anticipated for Hattuşa during the Hittite period (Table 4.7a). It was expected that post-collapse these provisioning systems might be disrupted, which would result in stronger evidence for direct provisioning, where butchery and consumption activities take place in the same general areas. Alternatively, our assumption was that if rural sites were not well-integrated with the broader economic system in central Anatolia during the Bronze Age (Table 4.7b), we might expect to see more evidence for direct provisioning at Çadır during the Hittite period, and that this pattern would continue after the empire's collapse.

The Hittite period cattle materials at Çadır display a fairly even distribution of skeletal parts (Fig. 5.22a); all parts of the carcass are more or less evenly represented. (Karum period materials were excluded due to sample size). In contrast, the Early and Middle Iron age cattle samples (Fig. 5.22ab) have a much more uneven distribution of skeletal parts compared to the

Hittite period assemblage. Most notably, extremities are highly over-represented in the Iron Age samples (by approximately 20%), suggesting that these body parts had a different depositional history than other parts of the cattle carcass and suggesting that these materials may represent butchery waste. Interestingly, these results, which seem to represent a shift from direct provisioning at Çadır during the Hittite period to indirect provisioning in the Iron Age, do not fit with the expectations for either of the interpretive models described above.

### *6.2.2 Caprines*

#### *Frequencies*

Assuming a strong degree of integration between rural economies and the regional Hittite economy, our expectation for caprines at Çadır during the Hittite period (Table 4.1a) was that there would be a high ratio of sheep to goats at this time given the role of wool production in regional trade during the Bronze Age in Anatolia (Arbuckle 2012), echoing our expectations for caprines at Hattuša at this time. We also expected that the collapse of the Hittite empire would result in a potential shift toward herd security approaches to production, as opposed to the maximization of commodity production and that, therefore, the ratio of sheep to goats would decrease (i.e. there would be an increase in the relative proportion of goats). On the other hand, assuming a general lack of integration between rural economies and the broader regional economy in the Hittite period, we might expect to see a relatively low sheep to goat ratio at Çadır during the Hittite period, which would likely be an aspect of a more conservative, low-risk herding strategy. Moving into the Iron Age, we would expect this signature to remain the same.

Generally speaking, the relative proportion of caprines at Çadır grows steadily over time from the mid-second into the early first millennium BC. (Fig. 5.2a) Caprine frequencies are

lowest in the Old Hittite (MB II) period (%NISP=31.7%), which is a notably low frequency given the time and place. Caprine frequencies peak at the site in the Early Iron (%NISP=68.6%) before dropping somewhat in the Middle Iron Age (%NISP=55.5%). However, this decrease is not precipitous and percentage-wise is on par with what we see with the Hittite Empire/Transitional material from the site (%NISP=53.9%). In terms of the sheep to goat ratios (Table 5.18), the sheep to goat ratio during the Middle Hittite period at the site is 1.82:1 (other Hittite materials were excluded due to small sample sizes). Moving into the Iron Age, the ratio of sheep to goats at the site decreases to 1.18:1 during the Early Iron Age and .95:1 during the Middle Iron Age.

The decrease in the sheep to goat ratio at Çadır from the Hittite period into the Early Iron Age (with the proportion of goats nearly doubling) fits in well with the integration model, suggesting that in this way the residents of Çadır were affected by and reacting to changes in economic organization in central Anatolia after the Hittite collapse. However, it is worth noting that the gradual growth in caprine percentages at Çadır continues across the Bronze/Iron transition—this growth does not stop until after the Early Iron Age. This evidence shows a strong degree of continuity even as the composition of caprine herds change (i.e. the percentage of goats increases) moving into the Iron Age.

### *Survivorship/Mortality*

As discussed elsewhere, our expectations for caprine survivorship were approached through two lenses: that of production (Table 4.2) and that of provisioning (Table 4.3). When considered in terms of production, our expectation was that, if the local economy at Çadır was well-integrated into the broader Hittite economic system, we would expect to see involvement in a regional economy that emphasized the commodity production of wool. In this case, kill-off

would take place late in life, as both female and male animals (particularly castrates) would be maintained well into adulthood for wool production (Table 4.2a). After the empire's collapse, we expected that with the disruption of the regional economy and the market for wool, producers at Çadır would move away from intensive wool production and instead might turn to a more generalized, low risk production strategy, emphasizing herd security and sustainability over commodity production. This shift in production goals would be accompanied by a more gradual kill-off pattern, with a smaller proportion of animals being kept into old age. If we imagine that the economy at Çadır during the Hittite period was largely independent from the Hittite economic system (Table 4.2b), we expected that the organization of production at Çadır would not change moving into the Iron Age, regardless of whether production was focused on generalized production/herd security (the model typical associated with rural sites) or on commodity production. In this case, we expected that patterns of caprine survivorship/mortality would show continuity across the Bronze/Iron transition.

With regard to how survivorship/mortality may reflect patterns of provisioning (particularly in terms of rural sites providing animals for larger centers, following Stein 1987), we expected that, if Çadır was involved in such a system, we might expect to see certain ages of caprines missing from the population at the site during the Hittite period. If Çadır was exporting market-aged/prime meat weight animals as part of a regional distribution system, we would expect the Hittite period caprine assemblage at Çadır to be dominated by younger and older animals and for the prime meat weight age group (2-3 years) to be largely absent (Table 4.3a). If, however, Çadır was exporting older animals that were no longer useful for secondary products production, we would expect to animals in this older age group to be largely absent at the site (Table 4.3b). After the Hittite collapse, we would expect there might be disruptions to this

regional market. If Çadır stopped supplying animals to other sites as a result of this, we would expect to see a shift in caprine age distributions such that animals would be present in all age categories. If, on the other hand, Çadır was never involved in such a regional market in the first place (Table 4.3c), we might expect to see all age classes at the site during the Hittite period and for this pattern to continue after the Hittite collapse.

During the Hittite period at Çadır (Fig. 5.5b), the majority of animals were being kept well into adulthood (mortality peaks between the ages of 3 to 6 years, Payne's wear stages F and G) and were killed after prime meat weight had been reached. This late kill-off, combined with the higher ratio of sheep to goats in the Middle Hittite period, may represent fiber production, which would fit with a model of a commodity-oriented regional economy/stability brought by the Hittites. However, this pattern could also relate to provisioning. Given the absence of young lambs and the abundance of older animals, this pattern may point toward a provisioning strategy for the Hittite settlement at Çadır, suggesting that the site may have been provisioned with older animals from the surrounding countryside. In contrast, during the Early Iron Age (Figure 5.5c), the gradual consumption of the caprines in the assemblage, visible in the relatively even distribution of age categories, is suggestive of a multi-use/generalized herding strategy in which animals are used for both primary (meat, skins) and secondary (milk, fiber) products and production is not intensive. Along with the growing frequency of goats relative to sheep in the Iron Age, this pattern suggests more local production and risk reduction. The bimodal distribution in the Middle Iron Age (Fig. 5.5d) is noticeably different from what appears in the other samples. It seems most likely that the complete absence of animals under six months and the near absence of prime meat weight animals is indicative that, during the Middle Iron Age,

caprines raised at Çadır were being sent elsewhere, possibly provisioning the nearby Iron Age settlement at Kerkenes Dağ.

### *Biometrics: Sheep*

If we assume Çadır's involvement in a regional market with an emphasis on wool production during the Hittite period, we would expect that a large proportion of male sheep/castrates would not be culled until later in life in order to maximize wool production (Table 4.4a). In terms of body size, this would result than a higher than usual proportion of large-bodied (male-sized sheep) appearing in the Hittite period assemblage at the site. Post-collapse, we might expect to see a decrease in this proportion of large-bodied male size animals accompanying a shift away from intensive wool production and toward more generalized, lower risk production strategies. Alternatively, if we assume that the economy at Çadır was not incorporated into the broader Hittite economic system, we would expect that the organization of production at Çadır would not be overly affected by the Hittite collapse, regardless of whether production was focused on generalized production/herd security (the model typical associated with rural sites) or on commodity production during the Bronze Age. In this case, we expected that body size distributions would show continuity across the Bronze/Iron transition.

Based on the LSI results (Fig. 5.10a), female sheep seem to greatly outnumber males in the Hittite sample at Çadır. This pattern would be in keeping with a production strategy that minimizes risk and emphasizes herd security, where a smaller number of adult males is kept for breeding purposes (Redding 1984; Payne 1973). Combined with the mortality results described above (where caprine mortality at Çadır does not peak until later in life), these results point toward the possibility of a conservative herding strategy in which animals were being kept alive

past prime meat weight. This interpretation is in line with the Hittite period caprine mortality results, discussed above.

During the Early/Middle Iron Age at Çadır, larger (presumably male) animals and smaller (presumably female) animals are represented in roughly even proportions (Fig. 5.10b). These results are difficult to interpret given the blurring that results from combining the sheep metrical data from the Early and Middle Iron Age periods and from the fact that the survivorship/mortality histograms combine age data from both sheep and goats. Notably, however, there is a clear decrease in the overall size range of Çadır sheep across the Bronze/Iron transition (perhaps signaling a change in sheep breed). This, combined with the increasing proportion of female animals over time does point toward shifts in sheep husbandry at the site that coincide with the Hittite collapse in the region.

To summarize briefly, we see in these results the possibility of a herd security approach to sheep production (which does not prioritize commodity production) during the Hittite period at Çadır, followed by a reorganization of production moving into the Iron Age. These results suggest changes in sheep husbandry at the site associated with the Hittite collapse, but they do not follow the expected direction (commodity production → herd security).

### *Biometrics: Goats*

As noted elsewhere, given that goat herd structures in the ancient Near East tended to be dominated by female animals with a few males kept for breeding, this is what we expected to see at Çadır both before and after the Hittite collapse, regardless of how we viewed the site's place within the broader Hittite economic structure. The goat biometric results from the Hittite period and the Early/Middle Iron Age at Çadır conform to these expectations. During the Hittite period,

specimens with smaller body sizes vastly outnumber specimens with larger body sizes (Fig. 5.12a), suggesting that the herd structure consists mainly of smaller female animals and that a few larger male animals are kept for breeding purposes, consistent with a conservative herding structure (Redding 1984). These patterns are repeated in the results for the Early/Middle Iron Age at the site (Fig. 5.12b), where the sample is dominated by smaller-bodied animals (likely females), and there are only a few larger-bodied animals (likely males). These results point toward continuity in goat husbandry patterns at Çadır before and after the Hittite collapse.

### *Skeletal Parts*

As has been discussed elsewhere, there was a general expectation that, assuming a strong degree of economic integration between rural sites and the Hittite state more broadly, the Hittite period at Çadır would show signs of indirect provisioning during the Hittite period, with a shift to indirect provisioning post-collapse. On the other hand, assuming that rural sites were not well integrated, we might expect to see more evidence for direct provisioning at Çadır during the Hittite period, and that this pattern would continue after the empire's collapse (Tables 4.7a; 4.7b).

For caprines during the Hittite period at Çadır, forelimb bones are the most over-represented skeletal elements (over-represented by approximately 11%) (Fig. 5.18a). This over-representation may point toward a degree of indirect provisioning of caprine meat at the site during this time, with butchery and consumption occurring in different areas. During the Iron Age periods (Fig. 5.18bc), there is an extreme over-representation of caprine heads (over-represented by more than 20%; increasing from around 6% over-represented in the Hittite period). The extreme over-representation of heads (normally associated with butchery waste)

points toward specialized provisioning at the site during the Iron Age and, due to its degree, may suggest an increase in specialization in terms of caprine provisioning at the site in these periods relative to the Hittite period. Thus we see some degree of continuity in this aspect in terms of the presence of indirect provisioning of caprine meat, but we see a difference of degree over time. The intensification of specialized caprine provisioning moving into the Early Iron Age does not fit well with either the integration or the non-integration model.

### *6.2.3 Pigs*

#### *Frequencies*

Assuming the integration model, it was expected that Çadır would have a relatively low proportion of pigs, which are associated with economic decentralization, and that that post-collapse, the proportion of pigs at the site would increase. Assuming the non-integration model, it was anticipated that the relative frequency of pigs at the site would be high during the Hittite period and that this pattern would continue moving into the Iron Age.

Frequencies of pigs at the site are highest during the Karum (MB I) period through the Middle Hittite period (LB I), ranging between 15-19% %NISP (Fig. 5.2). The percentage decreases noticeably during the Hittite Empire/Transitional period (to 6.6% %NISP) and is lowest during the Early Iron Age (4.4% %NISP). The frequency of pigs then increases somewhat moving into the Middle Iron Age (to 10.6% %NISP). The movement from a high frequency of pigs during the Karum period and the earlier part of the Hittite period to a very low frequency at the end of the Hittite period and into the Iron Age does not fit well with either model. If pigs are taken as a marker of decentralized household production, this pattern may indicate increasing centralization of production at Çadır after the Hittite collapse.

### *Skeletal Parts*

As was the case for the Hattuša pig samples, heads and forelimbs were the most abundant skeletal parts at Çadır. Again, the abundance of these elements (and the relative absence of hindlimbs, the axial skeleton, pelvises, and extremities) was interpreted as the result of density-mediated attrition.

### **6.3 Hattuša at the Level of the Site**

In order to develop an understanding of how animal management at Kesikkaya Northwest, Kesikkaya South, and Lower Town South fit in with what was occurring in other areas of the site, the species frequency signatures of these materials were compared with those recorded from other excavation areas when possible. This was done by comparing the materials described above with species frequency data from all excavation areas at Hattuša with published faunal reports (Table 2.2). These areas include the original excavations at the Lower Town (von den Driesch and Boessneck 1981), Büyükkaya (von den Driesch and Pöllath 2004), Sarıkale (Hollstein and Middea 2014), and the Middle Plateau (Berthon 2015). For the sake of this analysis, the data sets were grouped chronologically into three broad categories: the Pre-Hittite period (including the Karum period and Karum/Hittite transitional materials [MB I], approx. 1900-1680 BC), Hittite (including materials from the Old Kingdom through the Empire periods [MB II, LB I, LB II], approx. 1680-1200 BC), and Post-Collapse (including the Early Iron and Middle Iron materials, approx. 1200-700 BC). To ease comparison, only four broad taxon categories were used: sheep/goat, cattle, pig, and “other.” Calculations were made using NISP. Incorporating information from these published assemblages is critical, especially as they

include the only Early Iron Age faunal materials recovered at the site (from the excavations at Büyükkaya). Thus they offer a window into what was happening at the site immediately following the Hittite collapse.

In general, caprines dominate at Boğazköy-Hattuša (Figure 6.1). Hittite Sarıkale and Hittite Kesikkaya South provide the most extreme examples of this, with caprine frequencies at or exceeding 80%. The main exception is for the Lower Town during the Karum period, where cattle have the highest representation.

When visually comparing the histograms of the Hittite materials to those of the Early and Middle Iron Ages, there does not appear to be a dramatic shift in terms of the species frequencies post-collapse. For example, at Early Iron Age Büyükkaya, the only sample available for the period immediately following the Hittite collapse, caprines comprise the majority of the assemblage (59%), only a three percent decrease from caprine representation at Büyükkaya during the Hittite period. The frequency of cattle remains stable (33% during the Hittite period; 32% during the Early Iron Age) across the Bronze/Iron divide, and the frequency of pigs stays relatively small (3% in the Hittite period; 5% in the Early Iron Age). While the shapes of the Middle Iron Age distributions do differ from the Early Iron Age (as well as from one another), comparable distributions do exist among the Hittite materials from other excavations areas across the site. In essence, while some variation does exist in the species frequencies across the site (likely relating to differences in production goals/animal-related activities), these differences do not seem to track well with time or map onto a distinction between pre- and post-collapse categories.

## Hattuša Primary Food Taxa (NISP)

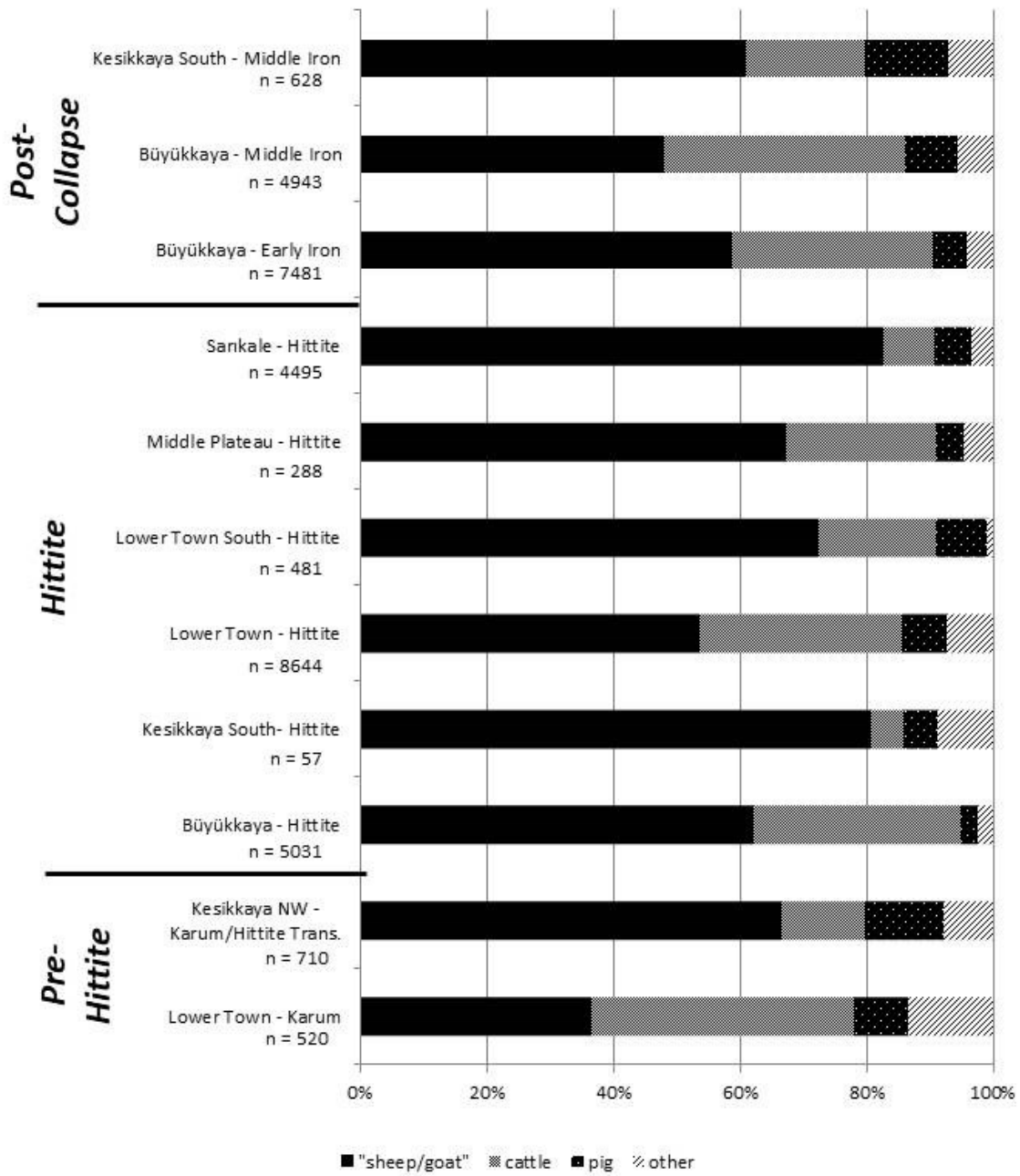


Figure 6.1 Overview of species frequencies over time at Hattuša (NISP).

That having been said, when the species frequencies for each of the large three chronological periods (Pre-Hittite, Hittite, and Post-Hittite) are averaged, some notable features become apparent (Table 6.1). When examined in this way, caprine frequencies are by far the highest in the Hittite period (Hittite mean = 70%; Pre-Hittite mean = 52%; Post-Collapse mean = 56%). This emphasis on caprine production during the Hittite period, could be indicative of an emphasis on intensive fiber production during a time of economic consolidation at the site. Simultaneously, pigs, often taken as a marker of decentralization (Zeder 1991), have their lowest representation during the Hittite period. Also of interest is the fact that, in general, the mean distributions for the Pre-Hittite and Post-Collapse periods are quite similar, with differences of less than 5% between them for each of the four categories (sheep/goat, cattle, pig, other). This suggests that, when examined on a macro level, animal husbandry practices at Boğazköy-Hattuşa differed during Hittite control of the site.

Sheep:goat ratios were also examined incorporating the published materials. Calculated using NISP, these can be found in Table 6.2. These frequencies range from 2:1 (Karum period Lower Town; Hittite Sarikale; Middle Iron Age Kesikkaya South) to nearly 4:1 (Hittite Büyükkaya). However, most of the sheep goat ratios were between 2:1 and 3:1. When these samples are grouped into three broad categories (Pre-Hittite, Hittite, and Post-Hittite/Iron) there is a drop in the sheep:goat ratio moving from the Hittite period (MBII/LBI/LBII) into the Iron Age (Table 6.3). This shift (Hittite mean=2.67; Iron Age mean 1.92) could point toward a shift away from intensive wool-production post-collapse, which aligns with the drop in overall caprine production at the site moving into the Iron Age.

	<b>Pre- Hittite</b>	<b>Hittite</b>	<b>Post- Collapse</b>
<b>cattle %</b>	0.274	0.200	0.295
<b>caprine %</b>	0.516	0.699	0.560
<b>pig %</b>	0.106	0.056	0.089
<b>other %</b>	0.104	0.045	0.056

Table 6.1 Hattuša Mean Species Frequencies

	Middle Bronze I		Middle Bronze II/Late Bronze					Early/Middle Iron		
area	Lower Town	Kesikkaya NW	Büyükkaya	Lower Town	Lower Town S	Middle Plateau	Sarı kale	Büyükkaya	Büyükkaya	Kesikkaya S
period	<i>Karum</i>	<i>Karum/Hittite Trans.</i>	<i>Hittite</i>	<i>Hittite</i>	<i>Hittite</i>	<i>Hittite</i>	<i>Hittite</i>	<i>Early Iron</i>	<i>Middle Iron</i>	<i>Middle Iron</i>
sheep	82	87	578	1602	33	42	202	674	378	58
goat	40	29	153	550	11	16	99	346	208	29
sheep:goat	2.05	3.00	3.78	2.91	3.0	2.63	2.04	1.947977	1.817308	2.0

Table 6.2 Comparison of sheep:goat ratios at hattuşa over time

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	Pre-Hittite (MBI)	Hittite (MBII/LB)	Post-Hittite (Iron)
mean	2.53	2.67	1.92
median	2.53	2.77	1.95

Table 6.3 Comparison of mean and median sheep to goat ratios at hattuşa over time

## 6.4 Final Thoughts

This chapter has condensed the results from the previous chapter, breaking down the results by site, species, and form of analysis, and placed the results in direct dialogue with the interpretive models set out in Chapter 4. The chapter then placed the results of analysis from Kesikkaya Northwest, Kesikkaya South, and the Lower Town South Area in conversation with data from other parts of the site at Hattuša. Broadly speaking, these results show while changes in central Anatolian economic organization did occur following the collapse of the Hittite empire, the nature of these changes does not always follow the trajectories assumed in conventional narratives of collapse. While in some instances, the data follow the anticipated direction (e.g. an overall decrease in the ratio of sheep to goats in the Hittite period vs. the Iron Age at both Hattuša and Çadır, indicating a decreased reliance on intensive wool-production in central Anatolia post-collapse), sometimes the data move in unexpected directions (e.g. the apparent increase in the specialized provisioning of cattle at Çadır after the Hittite collapse). These patterns along with their broader implications for collapse studies are discussed in depth in the following chapter.

## CHAPTER 7 SYNTHESIS AND CONCLUSIONS

The goal of this final chapter of the dissertation is two-fold. First, the aim is to bring together the results of the analysis of faunal materials from the Hittite capital Hattuša (particularly Kesikkaya Northwest, Kesikkaya South, and the Lower Town South Area) and Çadır Höyük in order to characterize the animal economies at these sites during the Middle to Late Bronze Age through the Early to Middle Iron Age. This discussion is oriented by an examination of the degree to which the results of the analysis from these two very different sites adhere to our general understanding of the Hittite state and its political and economic organization (discussed in Chapter 2) as well as to the “pre- and post-collapse” expectations set out in Chapter 4. These results are then placed in relation to faunal evidence from other sites of the central Anatolian plateau during the Bronze and Iron Ages. Ultimately, this discussion shows that, while changes in central Anatolian economic organization did occur following the collapse of the Hittite empire, the nature of these changes does not always follow the trajectories assumed in conventional narratives of collapse. Building off of this discussion, the second aim of this chapter is to mobilize the dissertation results from Hattuša and Çadır – and in particular, the ways in which they depart from expectations – to encourage further examination of how we think about collapse more broadly. In other words, the goal is to consider what these results imply about how we think about collapse and how we may need to rethink our collapse models.

As noted in the previous chapter, results from the analysis of the Bronze and Iron Age animal remains at Hattuša and Çadır Höyük do not fully align with the “pre- and post-collapse” expectations laid out in Chapter 4. A general summary of results from both sites (organized by taxon) can be seen in Table 7.1. The following discussion attempts to organize these complicated

and varied results in such a way as to comment on the organization of animal economies at these sites during the Hittite period and after its collapse.

As discussed in depth in Chapter 4, our expectation was that the results at Hattuša would show a general trend from centralized and/or specialized forms of economic organization during the Hittite period, moving toward less centralization and specialization after the Hittite collapse. This expectation was based on our general understanding of the Hittite economic order (see Chapter 2) as well as how collapse has typically been presented in the archaeological literature (see Chapter 3). At Çadır, it was anticipated that outcomes would vary depending on the site's place within the broader Hittite economic organization. It was expected, if Çadır was well-integrated into the Hittite economic order, its economy might show signs of economic centralization and specialization, with a shift toward decentralization post-collapse. If, on the other hand, the economic system at Çadır largely operated separately from the Hittite economic system, it was expected that the animal economy there would show more signs of decentralization during the Hittite period and, most notably, that its animal economy would show general signs of continuity post-collapse.

Table 7.1 Synthesis of results.

CATTLE	Çadir		Hattuşa	
	Hittite	Iron (Early/Middle)	Hittite	M. Iron (Kesikkaya South)
Species Frequencies	Lots of cattle	Big decrease in cattle	Fewer cattle than Çadir during Hittite period	Cattle % stays similar
Survivorship/Mortality	Some cattle killed off slightly younger (unfused)	Cattle older (fused)	Cattle older (fused)	Cattle older (fused)
Biometrics	Mostly female, a few males	Mostly female, a few males	Mostly female, a few males (Hittite Lower Town South exception)	Mostly female, a few males
Skeletal Parts	No separation of butchery and consumption waste	Separation of butchery and consumption waste	Separation of butchery and consumption waste at Hittite Kesikkaya South [present but lower intensity: Kesikkaya NW Karum/Hittite Trans.]	Some separation of butchery and consumption waste (decrease in intensity from Hittite period)

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CAPRINES	Çadir		Hattuşa	
	Hittite	Iron (Early/Middle)	Hittite	M. Iron (Kesikkaya South)
Species Frequencies	Caprine % grows steadily from Old Hittite (32% - quite low) through Hittite/Transitional period (54%)  Higher sheep:goat ratio [basically 2:1]	Caprine % peaks in Early Iron (69%) [continued growth/continuity]; drops to 56% in Middle Iron  Lowest sheep:goat ratio [basically 1:1 in Early/Middle]	High proportion of caprines [Karum/Hittite=67% Hittite = 70-80%]  Hittite period: high sheep:goat ratio [basically 3:1]	Somewhat lower proportion of caprines (60%)  Lower sheep:goat ratio [still "high," basically 2:1]
Survivorship/Mortality	Late kill-off (3-4 yrs) [could be related to wool production]	Early Iron: shift to more generalized production/risk reduction (kill-off spread out) Middle Iron: Çadir sending off youngsters and prime meat weight animals elsewhere [provisioning]	Kesikkaya NW Karum/Hittite Trans: Late peak in kill-off (3-4 yrs) [could be from wool production or provisioning] Lower Town South: kill-off at prime meat weight (suggests provisioning)	Late peak in kill-off (3-4 yrs) [could be from wool production or provisioning]
Biometrics	Sheep: smaller (female) sheep outnumber (larger) males [herd security]; abundance of sheep that	Sheep: larger (male) and smaller (female) in roughly even proportions (herd security?); really big sheep	Sheep: skew heavily large/male (secondary products); abundance of sheep that exceed size of standard animal	Sheep: more females than Bronze Age samples, but still skews large/male; still have

Table 7.1 (continued) Synthesis of results.

CAPRINES	Çadır		Hattuşa	
	<i>Hittite</i>	<i>Iron (Early/Middle)</i>	<i>Hittite</i>	<i>M. Iron (Kesikkaya South)</i>
	exceed size of standard animal Goats: lots of females, a few males	disappear (body size decrease) Goats: lots of females, a few males	Goats: lots of females, a few males	specimens w very large body sizes Goats: lots of males, a few females
Skeletal Parts	Limb bones most represented (forelimbs over-represented by 11%); specialized provisioning (butchery/consumption occurring in different areas)	Decrease in rel. proportion of limb bones and dramatic increase in head bones (from 6% over-represented in Hittite to 24% in Early Iron); specialized provisioning (butchery/consumption occurring in different areas)	Kesikkaya NW (Karum/Trans), Hittite Lower Town South: Body zones generally not over/under represented (within 6% of '0' axis)(butchery/consumption occurring in same place) Kesikkaya S Hittite: 8% over-representation of forelimbs; 12% under-representation of pelvises	Body zones not over/under represented (butchery/consumption occurring in same place)

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Pigs	Çadır		Hattuşa	
	<i>Hittite</i>	<i>Iron (Early/Middle)</i>	<i>Hittite</i>	<i>M. Iron (Kesikkaya South)</i>
Species Frequencies	Karum, Old Hittite, Middle Hittite: 15-19% Empire/Trans: 6.6%	Early Iron: 4.4% Middle Iron: 10.6%	Kesikkaya NW Karum/Hittite Trans: 12.5% Hittite Lower town south and Kesikkaya South: 5-8%	13% (higher than Hittite period)
Skeletal Parts	Heads and forelimbs most commonly represented (may be related to density)	Heads and forelimbs most commonly represented (may be related to density)	Heads and forelimbs most commonly represented (may be related to density)	Heads and forelimbs most commonly represented (may be related to density)

In some ways, the results of the faunal analysis do align with these expectations. For example, with regard to caprine production at Hattuša, we see a relatively high percentage of caprines at the site during the Bronze Age (ranging between approximately 70% and 80% at Kesikkaya Northwest, Kesikkaya South, and the Lower Town, South Area when measured by NISP). This high percentage of caprines is accompanied by a high ratio of sheep to goats (averaging out to approximately 3:1) during the Hittite period, and a high proportion of large-bodied, male-sized sheep, which tend to be maintained in large numbers primarily for the production of secondary products. Taken together, these signatures point toward the presence of a caprine production regime focused on the intensive production of wool during the Hittite period, which aligns well with our expectation that the Hittite capital would be involved in surplus commodity production, given the place of wool production in Near Eastern economies during the Bronze Age (Algaze 2008; Arbuckle 2012). In contrast, during the Iron Age at the site, we see a movement toward what might be read as a decrease in emphasis on the commodity production of wool, with an overall decrease in the frequency of caprines (to approximately 60% using NISP at Middle Iron Age Kesikkaya South), a decrease in the sheep to goat ratio (to approximately 2:1), and a decreased proportion of large-bodied, presumably male sheep. These changes in caprine signatures moving into the Iron Age could signal a shift toward more generalized and less specialized caprine production after the collapse of the Hittite empire.

The caprine story at Çadır on the other hand, displays some interesting departures from expectations. We anticipated in Chapter 4 that, if Çadır was well-integrated into a Hittite economy focused on the commodity production of wool, we might expect to find signs of intensified wool production at Çadır during the Hittite period as well as at the Hittite capital Hattuša, and that we might see a shift to less intensified production post-collapse. If, on the other

hand, the animal economy at Çadır was not well integrated into the broader Hittite economy, we expected caprine signatures to show signs of a production regime focused on generalized production and herd security/minimized risk and for these signatures to show continuity after the Hittite collapse. During the second half of the second millennium, caprine frequencies grow steadily at Çadır, from around 32% (a notably low percentage) based on NISP during the Old Hittite (MB II) period to around 54% during the Hittite Empire/Transitional period (LB II). Interestingly, growth in the percentage of caprines at the site continues to increase moving into the Early Iron Age, when the caprine frequency at the settlement reaches a high of approximately 69% by NISP before dropping back down to around 56% during the Middle Iron Age. This continuity of growth in caprine frequencies across the temporal transition associated with the Hittite collapse is quite interesting when placed in relation to the other caprine signatures.

Peak kill-off of caprines at Çadır is quite late (with a mode at 3-4 years). This late kill-off might be indicative of the production of secondary products (i.e. adult sheep, particularly females and castrated males, being kept alive well into adulthood for the production of wool). However, according to the biometric evidence smaller-bodied, female-sized sheep make up the majority of the assemblage. Taken together, the late caprine kill-off combined with the majority of female sheep reads more as a signature of risk avoidance and sustainability/herd security than of intensive commodity production.

Moving into the Iron Age, the proportional growth of caprines relative to other taxa is accompanied by a shift in the composition of caprine herds at Çadır – while the ratio of sheep to goats is almost 2:1 at the site during the Hittite period, during the Early Iron Age, the proportion of sheep decreases, and the sheep to goat ratio nears 1:1. Along with the rise in the proportion of goats, animals associated with hardiness and small-scale, decentralized production, caprine

mortality patterns shift to a gradual kill-off animals in all age groups over time, a kill-off pattern most consistent with what we typically envision when we think of production strategy focused on herd security and generalized production (Payne 1973). During the Middle Iron Age, the ratio of sheep to goats remains low (essentially 1:1) as the overall proportion of caprines in the assemblage decreases at the site for the first time in over half a millennium. At the same time, there is a striking shift in caprine survivorship/mortality patterns during this period, with very young animals and prime meat weight animals largely missing from the assemblage. This may very well suggest that during the Middle Iron Age, Çadır caprines in these age groups (which are desirable for meat consumption) were being sent elsewhere – perhaps to the nearby Middle/Late Iron Age fortress city at Kerkenes Dağ.

Thus, in some ways at Çadır, we see elements of continuity across the transition from the Bronze Age to the Iron Age – in terms of the continued growth in the overall proportion of caprines from the Bronze Age into the Iron Age, and in terms of the overall interpretation of caprine production strategies during the Hittite period and during the Early Iron Age, both of which can be read as emphasizing herd security and localized production rather than intensive commodity production. At the same time, we do see some changes that coincide with the end of the Hittite empire in central Anatolia – a decrease in the relative proportion of sheep to goats (which we also saw at Hattuşa, though on a different order of magnitude) and the overall composition of caprine herds in terms of age and the proportions of female to male sheep.

Discussions of Near Eastern animal economies have a tendency to focus on the role played by caprines; however, with regard to the organization of production at Hattuşa and Çadır before and after the Hittite collapse, studying the management of some of the more ignored barnyard animals – namely cattle and pigs – is equally informative. Earlier we noted the

symbolic association between cattle and wealth/status in the ancient Near East (Arbuckle 2014b). We hypothesized that, for this reason, we might expect to find an abundance of these animals at the Hittite capital and a decrease in their relative frequency during the Iron Age. However, in terms of relative species frequencies, the Bronze Age samples from Hattuša do not contain an over-abundance of cattle (though they were clearly an important part of the animal economy at the site), and the cattle frequency is similar in the Middle Iron Age sample from the site.

On the other hand, cattle frequencies during the Hittite period at Çadır are very high—much higher than those at the Hittite capital—especially when calculated by bone weight (as a proxy for meat weight, following Uerpmann 1973). When cattle are read as a marker for wealth and status, the dominance of cattle in the Hittite period faunal assemblage at rural Çadır is a bit perplexing. It is, of course, possible that local elites at Çadır were consuming cattle during the Hittite period (and there is some fusion evidence for the consumption of younger cattle at the site during the Hittite period, which is absent from Iron Age samples at the site and from the Hattuša samples in both the Bronze and Iron Ages). Moreover, if Gorny's (2005) identification of Çadır as a Hittite ritual center (which was visited by the Hittite king as part of a yearly circuit) is accurate, this could help account the high proportion of cattle at the site. However, it seems equally likely that the abundance of cattle at Çadır during the Hittite period has to do with agricultural practice. Miller et al. (2009) have noted a correlation between an uptick in cattle in the faunal record and periods of intensified agricultural production. Thus, the abundance of cattle at Çadır at this time may point toward the importance of cattle for traction in agricultural production at the site during the Hittite period. It is also in line with what we know about the presence of large-scale grain storage at the Hittite capital during this time (Schachner 2011; Seeher 2002), which could have been used to store agricultural surplus from smaller rural sites

like Çadır. If this interpretation is correct, the precipitous drop-off of in the relative abundance of cattle at the site moving into the Iron Age likely suggests a major re-orientation of agro-pastoral production at the site around the time of the Hittite collapse. Combining these results with the caprine signatures discussed above, this shift in production likely entailed an increased focus on caprine management with an emphasis on herd management strategies that prioritized herd security and generalized production.

Tracing the results of pig production at these two sites across the transition from the Bronze to the Iron Age also offers some useful insights. As noted in previous chapters, in complex societies, an emphasis on pig production can be indicative of unregulated, house-hold level production. At Hattuşa, then, we might expect the disruption of economic systems (including provisioning systems that would have supplied consumers with meat) following the Hittite collapse to be accompanied by an increase in pig production during the Iron Age at the site. This does indeed appear to be the case in the samples included here, with a relatively low frequency of pigs during the Hittite period (ranging from around 5-8% by NISP), and an increase in the Middle Iron Age sample (to approximately 13% by NISP).

At Çadır, in contrast, the pig frequencies move in an unexpected direction. Pig frequencies are high in the Middle Bronze Age (Karum and Old Hittite) and during the first part of the Late Bronze Age (Middle Hittite), ranging from 15-19% by NISP, but they decrease noticeably during the Hittite Empire/Transitional period, to around 7%. They drop even further during the Early Iron Age (to around 4.4%) before increasing (to around 11%) during the Middle Iron Age. If pigs are read as markers of decentralized production, the decrease in the relative proportion of pigs at the site during the Hittite Empire/Transitional period and the Early Iron Age

might be seen as an indicator of increasing centralization at Çadır around the time of the Hittite collapse, which doesn't fit well with our models.

In terms of potential cultural attitudes towards pigs, Collins (2006) has discussed how the rare references to the consumption of pork in the Hittite texts occur within ritual contexts. This, she argues, suggests that “special religious significance was sometimes attached to the eating of pig's flesh” (Collins 2006: 6). She notes that, in its sacrificial role, pig flesh became equivalent to and a stand-in for human flesh. She also points out that they were considered unclean for the Hittites and were not allowed in temple areas. These cultural associations may have affected attitudes toward pig consumption, and it's possible that the low pig frequencies we see at Hattuşa during the Hittite period may relate to a general avoidance of pig meat rather than simply reflecting a lack of decentralized meat production at the household level.

In this light, the fact that pig frequencies are relatively high at Çadır during the earlier parts of the Hittite period but decrease substantially toward the end of the period may reflect a stronger Hittite cultural influence at the site during the later parts of the Hittite period which continued into the Early Iron Age, when pig frequencies drop even further at the site. This kind of continuity across the Late Bronze/Early Iron transition is not unheard of at Çadır. In terms of ceramics, the transition to the Iron Age in central Anatolia is often characterized by a shift from Hittite mass-produced wheel-thrown wares to hand-made ceramics during the Iron Age. Excavations from the beginning of the Early Iron Age at Çadır, however, have yielded hand-made wares that imitate the characteristic features of Hittite ceramics that were produced on a wheel (Ross 2010), pointing toward a situation where the form of the Hittite ceramics was still desired, even as the economic system that had produced them had fragmented.

Zooming out to the level of the central Anatolian region, preliminary comparative analysis conducted by the author (Adcock 2016; 2015) can shed some additional light on the complexity of the economic shifts taking place in the region at this time. As part of this work, published species frequencies from two other sites on the Anatolian plateau, Gordion (Zeder and Arter 1994) and Kaman-Kalehöyük (Hongo 2004; 1996) were compared with results from Hattuša and Çadır Höyük. Like Çadır, Kaman was a rural center during the Bronze and Iron Ages, whereas Gordion was a larger regional center (and would become the capital of Phrygia later during the Iron Age), and both were continuously occupied across the Bronze/Iron transition.

Comparison of species frequencies across these sites revealed a strong degree of variation. For example, as similarly sized rural centers both located in the Hittite heartland, it was expected that the organization of animal economies at Çadır and Kaman would be similar in during the Hittite period. However, Kaman lacked the high proportion of cattle seen at Çadır during the Middle to Late Bronze Age; instead, the site was dominated by caprine production, the importance of which was underscored by a higher sheep to goat ratio, more in keeping with the sheep to goat ratios seen at Hattuša. Likewise at Kaman, there is an increase in the proportion of pigs moving into the Early Iron Age, whereas pig frequencies at Çadır during this time are quite low. More work needs to be done to understand the nuances of the differences in animal economies across central Anatolia in the periods surrounding the Hittite collapse, but this preliminary work indicates that what was happening on the ground in central Anatolia during the Hittite period and after is much more complicated than is often suggested by narratives that group sites by size and assume economic decentralization post-collapse.

Turning back to the stories the animal bones tell us about Hattuşa and Çadır specifically, we can make some general assertions about the patterns associated with the collapse of the Hittite empire. At Hattuşa, particularly with regard to the results from Kesikkaya Northwest, Kesikkaya South, and the Lower Town South Area, there does appear to be a general shift in organization toward greater decentralization in the production and provisioning of animal products during the Iron Age. This is evidenced, for example, in the apparent decrease in emphasis on intensive wool production and in the general increase in patterns for direct provisioning in the Iron Age sample (discussed in depth in Chapter 6). These results, however, must be taken cautiously for two reasons. First, the Iron Age materials included here date to the Middle Iron Age, meaning that we are missing evidence from the period immediately following the Hittite collapse. Second, when we begin to compare the results from these excavation areas at Hattuşa with previously published data from other parts of the site (discussed in Chapter 6) – which do include an Early Iron Age sample from Büyükkaya – the analysis points toward a high degree of synchronic variation in the management of animal resources at the site, which may be more pronounced than variation at the site over time. Planned future work will attempt to further characterize animal management at the settlement during the Bronze and Iron Ages through the incorporation of additional aspects of these published data (osteometrics, caprine age at death, etc.). It seems particularly worthwhile to further examine these data in order to gain fuller insight into the spatial variations in animal management across the site during different phases of the Hittite period as the fortunes of the Hittite state waxed and waned.

At the same time, the data from Çadır contradict narratives that paint rural Anatolian lifeways as constant and largely unaffected by overarching political and economic political systems. It seems that a major reorganization of the animal economy at Çadır occurred around

the same time as Hittite state lost its influence in central Anatolia, from a system focused largely on cattle and agricultural production to one more focused on risk-averse sheep and goat pastoralism. This having been said, this configuration is not one that was anticipated by the “integration” model discussed in Chapter 4. Moreover, some aspects of the Çadır results, such as the variation in pig frequencies at the site over time, are completely unaccounted for by our models, regardless of what we assume about Çadır’s “integration” into the Hittite sphere, nor do they fully follow a pattern of changes from centralized to decentralized economic organization.

The results of this analysis of faunal data from Hattuşa (Kesikkaya Northwest, Kesikkaya South, and the Lower Town South Area) and Çadır Höyük, as well as the results of the preliminary comparison with published data from Kaman-Kalehöyük and Gordion, can be said to capture the inherent “messiness” which is a reality of life on the ground. But, they also highlight the failures of our models of collapse, and of social and economic organization of life during the Hittite period, to account for these realities.

Contemporary work on the Hittite world and the aftermath of its collapse is actively working to complicate our ideas of life in central Anatolia during the second and first millennia BC. Schachner (2020) has recently pointed out that the city of Hattuşa as we see it today on the ground, and as it appears on site plans, is an amalgamation of building projects conducted over centuries, that were occupied at different times and then abandoned or reconfigured. His emphasis on the unevenness of occupation at the site at any given point in time underscores how the place we think of as Hattuşa, which has been the primary analytical object of Hittite archaeology for over a century, never existed as we envision it, at least not as a totality. At any given moment, he writes, occupation within the massive fortification walls of the settlement was not spatially continuous, and he notes that in the empire’s final decades monumental building

projects continued at even as vast swaths of the site were left unoccupied forming a kind of wasteland.

At a broader level, coming out of his work at Kınık Höyük in southern Cappadocia, D'Alfonso (2020) has recently argued for a strong degree of intra-regional variation in local responses to the Hittite collapse in different parts of central Anatolia, emphasizing “[t]he presence of many different outcomes, their volatility, and the lack of one overarching model [to account for them]” (D'Alfonso 2020: 105). This recent work underscores the potential porousness of Hittite power in the region during the Late Bronze Age, or at least variation in how this power was distributed and manifested across central Anatolia.

The idea that there might be different “versions” or “manifestations” of the Hittite state that varied across time and space is one that fits well with the variations in the zooarchaeological evidence brought to light here. At the same time, this idea of the state power being unevenly distributed does not align well with versions of the state embedded in theorizations of collapse that conceptualize the state as a systematic totality. As noted in Chapter 1, these imaginings of the ancient state seem to be shaped by contemporary understandings of the modern nation state, where, ideally, the power of the state is continuous regardless of where one falls within its borders (Anderson 2006).

The zooarchaeological results from Hattuša and Çadır suggest that the complexities of animal management at these sites during the Bronze and Iron Ages are not well accounted for by our existing models of Hittite political and economic organization or of the empire's collapse. Taken as a whole, these results demonstrate a need to rethink how we envision the Hittite empire's political and economic organization. They underscore the need to move away from

thinking of ancient states as monolithic totalities. Moreover, these results highlight ways in which the existing models of societal collapse simply fail to account for the data on the ground.

Recent work in the field of collapse studies (e.g. Yoffee and McAnanay 2010; Faulseit 2017) has noted a need to shift our focus away from collapse as final event and have emphasized themes such as resilience and transformation. However, as we continue to revise our ideas about what happens after “the end” it may be worth considering whether collapse is in fact a useful analytic for describing what we see on the ground. It certainly seems clear in terms of both the archaeological and textual records that the entity we think of today as the Hittite state, consisting of a royal court at Hattuša, ceased to exist as such sometime around the turn of the 12<sup>th</sup> century BC. But as the results here show, what that actually meant for people living in and around the Hittite capital and at provincial towns like Çadır is open to a measure of debate. In this sense, to say that the Hittite empire “collapsed” actually tells us little about these everyday realities. Instead, the faunal data discussed here suggest that “collapse” resulted in reorganization, renegotiation, and a re-shuffling of priorities related to herding, animal products, agricultural products, and markets and provisioning systems.

## APPENDIX: HATTUŞA/ÇADIR HOYUK CODING PROTOCOL

I. Site/Archaeological Context: variable depending on excavation system used at a particular site.

**Site:**

**Excavation year:**

**Context of Deposition:**

**Period:** cultural or chronological period of deposit

**Recovery methods:**

- 0 unknown
- 1 hand picked
- 2 all screened
- 3 % screened
- 4 flotation

**Date analyzed:** date material studied

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## II. Identification

**Unique Bone Number:** 0000, given to elements/skeletal parts that are identifiable to element, and if they are measurable, or are otherwise deemed significant. Given to every line in database.

**Articulation:** definitely articulates with the bone(s) of the number recorded in this column (e.g. a mandible with teeth is coded as UBN 0001, then each associated tooth is entered with Articulation 0001).

**Element:** Altered from Meadow 1978 BONECODE.

0	26 atlas
1 skull	27 axis
2 basioccipital	28 cervical vertebra
3 occipital	29 thoracic vertebra
4 sphenoid	30 lumbar vertebra
5 pterygoid	31 sacrum
6 vomer	32 caudal vertebra
7 palatine	33 rib
8 interparietal	34 costal cartilage
9 parietal	35 sternabra
10 frontal	36 scapula
11 petrous	37 clavicle
12 temporal (squam.)	38 humerus
13 zygomatic/jugal	39 radius
14 lacrimal	40 ulna
15 nasal	41 carpal
16 premaxilla with teeth	42 radial carpal
17 premaxilla without teeth	43 intermediate carpal
18 maxilla with teeth	44 ulnar carpal
19 maxilla without teeth	45 accessory carpal
20 mandible with teeth	46 carpal I
21 mandible without teeth	47 carpal II
22 horn core	48 carpal III
23 antler	49 carpal IV
24 hyoid	50 radial + intermediate
25 vertebra(e)	51 carpal II + III

52 MC I	79 astragalus
53 MC II	80 calcaneum
54 MC III	81 tarsal
55 MC IV	82 central tarsal
56 MC V	83 tarsal I
57 MC III + IV	84 tarsal II
58 MC n.d.	85 tarsal III
59 ant prox sesamoid	86 tarsal IV
60 ant dist sesamoid	87 tarsal central + IV
61 anterior sesamoid	88 tarsal I + II
62 ant phalanx 1	89 tarsal II + III
63 ant phalanx 2	90 MT I
64 ant phalanx 3	91 MT II
65 ant phalanx	92 MT III
66 pelvis	93 MT IV
67 ilium + ischium	94 MT V
68 ilium + pubis	95 MT III + IV
69 ischium + pubis	96 MT n.d.
70 ilium	97 post prox sesamoid
71 ischium	98 post distal sesamoid
72 pubis	99 post sesamoid
73 os penis	100post phalanx 1
74 femur	101post phalanx 2
75 patella	102post phalanx 3
76 tibia	103post phalanx
77 fibula	104metapodial III + IV
78 lateral malleolus	105metapodial n.d.

106prox sesamoid	118long bone fragment
107dist sesamoid	119unidentified fragment
108sesamoid	120mollusk valve
109phalanx 1	121crustacean claw
110phalanx 2	122egg shell
111phalanx 3	123carapace / plastron
112phalanx n.d.	124
113tooth in premaxilla	125coracoid
114tooth in maxilla	126carpo-metacarpus
115tooth in mandible	127tarso-metatarsus
116loose tooth	128tibio-tarsus
117tooth fragment	

**Taxonomy:** altered from Meadow 1978 BONECODE.

0 unknown	11 small bovid
1 very small (< rodent)	12 medium bovid
2 small (hare-size)	13 Ovis/Capra/Gazella
3 medium (Ovis/Capra/Gazella size)	14 Ovis/Capra
4 large-medium (large Sus size)	15 <i>Ovis</i> sp.
5 medium-large (small Bos size)	16 <i>Capra</i> sp.
6 large (Bos size)	17 <i>Capra aegagrus/hircus</i>
7 very large ( $\geq$ Camel size)	18 <i>Capra ibex</i>
8 small artiodactyl	19 medium ruminant: bovid/cervid
9 medium artiodactyl	20 <i>Gazella</i> sp.
10 large artiodactyl	21 <i>Gazella bennetti</i>
	22 <i>Gazella dorcas</i>

- |   |                                    |
|---|------------------------------------|
| 23 <i>Gazella gazella</i>                   | 50 <i>Equus</i> sp.                |
| 24 <i>Gazella subgutturosa</i>              | 51 <i>Equus hydruntinus</i>        |
| 25 gazelle/antelope                         | 52 <i>Gazella</i> /antelope/cervid |
| 26 <i>Boselaphus tragocamelus</i>           | 53 <i>Boselaphus</i> /cervid       |
| 27 <i>Bos</i> sp.                           | 54 <i>Rhinoceras</i>               |
| 28 <i>Bos taurus</i>                        | 55                                 |
| 29 <i>Bos indicus</i>                       | 56 Small carnivore                 |
| 30 <i>Bison</i> sp.                         | 57 Medium carnivore                |
| 31 <i>Bubalus</i> sp.                       | 58 Large carnivore                 |
| 32 large bovid: <i>Bos</i> / <i>Bubalus</i> | 59 Viverrid                        |
| 33 small cervid                             | 60 <i>Herpestes</i> sp.            |
| 34 medium cervid                            | 61 <i>Herpestes auropunctatus</i>  |
| 35 large cervid                             | 62 <i>Herpestes ichneumon</i>      |
| 36 <i>Capreolus</i> sp.                     | 63 <i>Herpestes edwardsi</i>       |
| 37 <i>Cervus elaphus</i>                    | 64 Ichneumenia                     |
| 38 <i>Dama</i> sp.                          | 65 <i>Genetta</i> sp.              |
| 39 <i>Dama dama</i>                         | 66 Hyaenidae                       |
| 40 <i>Dama mesopotamica</i>                 | 67 small felid (cat size)          |
| 41 <i>Sus scrofa</i>                        | 68 medium felid                    |
| 42 Antilopinae                              | 69 large felid                     |
| 43 <i>Camelus</i> sp.                       | 70 <i>Felis cattus</i>             |
| 44 small/medium equid                       | 71 <i>Felis chaus</i>              |
| 45 large equid                              | 72 <i>Felis margarita</i>          |
| 46 <i>Equus asinus/hemionus</i>             | 73 <i>Felis manul</i>              |
| 47 <i>Equus asinus</i>                      | 74 <i>Caracal caracal</i>          |
| 48 <i>Equus hemionus</i>                    | 75 <i>Lynx lynx</i>                |
| 49 <i>Equus caballus</i>                    | 76 <i>Panthera leo</i>             |

77	<i>Panthera pardus</i>	104
78	<i>Panthera uncia</i>	105
79	<i>Acinonyx</i> sp.	106 <i>Ursus</i> sp.
80		107 <i>Ursus arctos</i>
81	small mustelid	108
82	large mustelid	109 <i>Procapra capensis</i>
83	<i>Martes foina</i>	110
84	<i>Vormela peregusna</i>	111 Erinaceid
85	<i>Mustela nivalis</i>	112
86	<i>Meles meles</i>	113
87	<i>Mellivora</i> sp.	114
88	<i>Lutra</i> sp.	115 <i>Talpa</i> sp.
89	<i>Mustela putorius</i>	116
90	small canid	117
91	medium canid	118
92	large canid	119
93	<i>Canis</i> sp.	120 Rodentia
94	<i>Canis aureus</i>	121 <i>Mus</i> sp.
95	<i>Canis familiaris</i>	122 <i>Rattus</i> sp.
96	<i>Canis lupus</i>	123 <i>Castor fiber</i>
97		124 <i>Sciurus</i> sp.
98		125
99	<i>Vulpes zerda</i>	126
100	<i>Vulpes</i> sp.	127
101	<i>Vulpes cana</i>	128
102	<i>Vulpes ruppelli</i>	129
103	<i>Vulpes vulpes</i>	130

131	158
132	159
133	160
134	161
135	162
136	163
137	164
138	165
139	166
140	167
141	168
142	169
143	170 <i>Homo sapiens</i>
144	171
145 <i>Spalax</i> sp.	172
146	173
147	174
148	175
149	176
150 Lagomorpha	177
151 <i>Lepus</i> sp.	178
152 <i>Lepus capensis</i>	179
153	180 Reptilia
154	181 Testudo
155	182 Serpentes
156	183 Amphibian
157	184 Pisces

**Certainty:** how certain ID is

- 0
  - 1 certain and checked with comparative specimen ( $\geq 95$  % confidence)
  - 2 certain ( $\geq 90$  % confidence)
  - 3 maybe? (c. 66 % confidence)
  - 4 not sure?? Need help! ( $< 66$  % confidence)
- 

### III. Descriptive

**Skeletal Part:** for long bones, pelvis, calcaneum, astragalus. Describes what general portion of the element is present.

- |  |  |
|--|--|
| 0 unknown  | 3 distal end (horncore tip; cranial pubis-symphysis) |
| 1 proximal end (horncore base; caudal pubis-acetab.) | 4 proximal shaft                                     |
| 2 shaft  | 5 distal shaft                                       |
|  | 6 proximal + shaft + distal                          |

**Skeletal Part 2:** used for skull elements, horncore, mandible, vertebra, sacrum, other tarsals and carpals.

- |                                  |  |
|----------------------------------|--|
| 0                                | 5 lateral (use with crania, vertebra zygapophyses) |
| 1 epiphysis (if loose epiphysis) | 6 central (vertebrae with centrum)                 |
| 2 cranial (Anterior)             | 7 spinal/transverse process                        |
| 3 caudal (Posterior)             | 8 symphysis/incisor/diastema area                  |
| 4 medial                         | 9 cheek/alveolus                                   |
| 4.5 medial/lateral?              |  |

10 mandible articular process

11 mandible coronoid process

12 diastema + cheek

13 cheek + articular/coronoid process

14 acetabulum

15 radius + ulna

16 horncore/antler + frontal

17 braincase

18 ulna shaft where fuses with radius

19 foramen

**Symmetry:**

0 unknown

1 left

2 right

3 left + right (e.g., furcula, fused pelvis)

4 axial

**Fragment Size:** approximate percentage of complete element (unless Skeletal Part 2 = 1, then describe % of epiphyses).

0 unknown

1 0 – 1/4

2 1/4 - 1/2

3 1/2 – 3/4

4 3/4 - 1

5 complete

**Origin of Fracture:** what is estimated source of the greatest part of the breakage in the bone? If 2 then count only large fragments under Count (2's will be treated differently during quantification).

0 unknown

- 1 mostly ancient breaks, > 50 % (count all pieces)
- 2 mostly modern breaks, > 50 % (only count larger pieces)

**Fragment Dimension:** greatest dimension in mm

**Proximal Fusion:** state of epiphyseal fusion (pubis fusion in acetabulum; coracoid process of scapula)

- 0 unknown
- 1 unfused
- 2 fused
- 3 fusing (prominent line w gap)

**Distal Fusion:** (pubis fusion at symphysis; calcaneus fusion)

- 0 unknown
- 1 unfused
- 2 fused
- 3 fusing (prominent line w gap)

**Sex:** skeletal sex derived from morphology of canine, cranium, horncore, antler, pelvis, tarsometatarsus spur, *os penis*.

- |           |                 |
|-----------|-----------------|
| - n/a     | 3 maybe male?   |
| 0 unknown | 4 maybe female? |
| 1 male    | 5 castrate      |
| 2 female  | 6 castrate?     |

**Modification 1:** cutmarks or tool marks

- |       |                |
|-------|----------------|
| - n/a | 0 none present |
|-------|----------------|

- |   |                              |               |                              |
|---|------------------------------|---------------|------------------------------|
| 1 | chopped                      | 7             | tool                         |
| 2 | possibly chopped?            | <del>8</del>  | <del>carnivore gnawing</del> |
| 3 | cutmark(s)                   | <del>9</del>  | <del>rodent gnawing</del>    |
| 4 | possible cutmark(s)?         | <del>10</del> | <del>digested</del>          |
| 5 | worked/ polished             | 11            | other (see comments)         |
| 6 | possibly worked or polished? |               |                              |

**Cutmark location: (added 2009)**

See Figures from Dobney and Rielly 1988 for element codes for location of cutmarks.

**Modification 2: carnivores (added 2009 as separate column)**

1. carnivore gnawing (punctures, tooth scrapes, furrowing, etc.)
2. rodent gnawing
3. digested
4. other (see comments)

**Burning**

- n/a
- 0 none
- 1 carbonized
- 2 partially carbonized
- 3 white/grey
- 4 partially white/grey
- 5 carbonized and white/grey

**Weathering Stage**

	Large mammals	Small mammals
0	no modification	no modification
1	longitudinal cracking, articular surfaces with mosaic cracking	slight longitudinal splitting of dentine
2	exfoliation of outer surface, cracking with angular edges	extensive splitting, little flaking
3	compact bone rough and fibrous; weathering penetrates 1-1.5 mm; crack edges rounded	deep splitting with flakes; extensive tooth splitting
4	coarse fibrous rough surface; splinters on surface; open cracks	coarse fibrous rough surface; splinters on surface; open cracks
5	bone falling apart in situ; large splinters; very fragile	bone falling apart in situ; large splinters; very fragile

Table A.1 Weathering Stage (from Behrensmeyer 1978 and Andrews 1990, from Lyman 1994:355)

**Pathology:** identifiable abnormal bone growth or resorption (describe severity in Comments section).

- n/a
- 0 none
- 1 exostosis near joint
- 2 exostosis not near joint
- 3 abnormal resorption/lesion near joint
- 4 abnormal resorption/lesion not near joint
- 5 enamel defect
- 6 other

**Count:** number of elements present.

**Weight:** weight of element(s) in grams to the nearest 0.1, or 0.5 gram depending on size of element and quality of scale.

**Diagnostic Zone:** DZ=highly diagnostic portion of an element. All articular ends of long bones get a DZ as does neck of scapula, acetabulum, atlas, axis, calcaneum, astragalus, mandible with teeth, loose dp4, P/4, M3 (carnassials for carnivores) or highly identifiable part such as glenoid and neck of scapula, acetabulum, atlas (e.g. proximal first phalanx gets DZ=1; complete first phalanx gets DZ=2). Used in quantification and in fragmentation indices.

- 0 no diagnostic zones present
- 1 one diagnostic zone present
- 2 two diagnostic zones present (e.g., complete phalanx 1 and 2, calc)
- 3 three diagnostic zones present (pelvis=ilium+ischium+pubis)

**Comments:** any distinguishing features of the specimen.

**Photographed?** Was the specimen documented with a photo or scan (for pathology, etc.)?

---

#### IV. Teeth

**Upper/Lower:** maxillary or mandibular teeth.

- 0 unknown
- 1 maxillary
- 2 mandibular

**Deciduous/Permanent:** deciduous or permanent teeth

- 0 unknown
- 1 deciduous
- 2 permanent

**Tooth class:**

- 0 unknown
- 1 Incisor
- 2 Canine
- 3 Premolar
- 4 Molar
- 5 Incisor/Canine
- 6 Premolar/Molar

**Tooth number:**

- |   |         |   |        |
|---|---------|---|--------|
| 0 | unknown | 4 | 4      |
| 1 | 1       | 5 | 1 or 2 |
| 2 | 2       | 6 | 2 or 3 |
| 3 | 3       | 7 | 3 or 4 |

**Wear stage:** For *Ovis* and *Capra* tooth wear, follow Payne (1973). For *Bos* and *Sus* tooth wear follow Grant (1982). Incisors, lower dp1-3, P1-3, maxillary teeth, and species other than sheep, goat, cattle, and pig get general wear descriptions (i.e. unworn, light wear, medium wear, heavy wear, or very heavy wear). Exceptions: Age canid (dog/wolf/fox) mandibular first molars after Stiner (1990), and age ursid mandibular first and second molars after Stiner (1990).

**Crown height/Collar width:** For aging caprines after Ducos (1968) and Helmer et al. (2007). Follow age categories described by Helmer et al. (2007). **\*\*USE FOR MAXILLARY MOLAR TEETH ONLY\*\***

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## V. Measurements

**M1, M2...Mn:** specific measurement(s) value(s) taken for element. See von den Driesch (1976) unless otherwise stated. Bold are for frequently used caprine measurements.

### Miscellaneous tooth:

1. GL
2. GB (buccal-lingual at the collar for bovids)

#### Atlas:

- 1 GB
- 2 GL
- 3 BFcr
- 4 BFcd
- 5 GLF
- 6 Lad
- 7 H

#### Axis:

- 1 LCDe
- 2 LAPa
- 3 **BFcr**
- 4 Bpacd

- 5 BPtr
- 6 SBV
- 7 BFcd
- 8 H
- 9 **Breadth dens**

#### Sacrum:

- 1 GL
- 2 PL
- 3 GB
- 4 BFcr
- 5 HFcr

#### General Vertebrae:

- 1 PL

- 2 GLPa
- 3 BPacr
- 4 BPacd
- 5 BPtr
- 6 BF(cr/cd)
- 7 HF(cr/cd)
- 8 H

**Scapula:**

- 1 HS
- 2 DHA
- 3 Ld
- 1 SLC**
- 2 GLP**
- 3 LG**
- 4 BG**
- 8 HC**

**Humerus:**

- 4 GL**
- 5 GLI
- 6 GLC
- 7 Bp
- 8 Dp
- 9 SD**
- 10 Bd**
- 11 BT**
- 12 HT**
- 13 HTmid**
- 14 HTlat**
- 15 Ddm**
- 16 BV

**Radius:**

- 1 GL**
- 2 PL
- 3 LI

- 4 Bp**
- 5 BFp**
- 6 Dp**
- 7 SD**
- 8 CD
- 9 Bd**

**10 BFd**

**11 DFd**

**12 Dd**

13 Bd of ds diaphysis  
(ruminants)

13 BRC (breadth radial  
condyle Equids)

14 BUC (breadth ulnar  
condyle, Equids)

**Ulna:**

- 1 GL
- 2 LO
- 3 DPA**
- 4 SDO
- 5 BPC**

**Pelvis:**

- 1 GL
- 2 LA**
- 3 LAR**
- 4 LS
- 5 SH
- 6 SB
- 7 SC
- 8 Lfo
- 9 GBTc
- 10 GBA
- 11 GBTi
- 12 SBI
- 13 Height Pubis

**Femur:**

- 1 GL
- 2 GLC
- 3 **Bp**
- 4 BTr
- 5 **DC**
- 6 SD
- 7 CD
- 8 **Bd**
- 9 see equid figure
- 10 see equid figure
- 11 see equid figure

**Patella:**

- 1 GL
- 2 GB

**Tibia:**

- 1 **GL**
- 2 LI
- 3 **Bp**
- 4 **Dp**
- 5 **Dpl**
- 6 **SD**
- 7 CD
- 8 **Bd**
- 9 **Dd**
- 10 see equid figure
- 11 see equid figure
- 12 see equid figure
- 13 see equid figure

**Fibula:**

- 1 GL

**Os Malleolare:**

- 1 GD

**Misc. Carpal:**

- 1 GB

**Astragalus: (equidae) (from Eiseman 1986; see Figures) (added 2005):**

- 1 (GH)
- 2 LmT
- 3 GB
- 4 trochlear breadth
- 5 BFd
- 6 distal art depth
- 7 medial depth

**Astragalus: (artiodactyla)**

- 1 **GLI**
- 2 **GLm**
- 3 **DI**
- 4 Dm
- 5 **Bd**

**Calcaneus:**

- 1 **GL**
- 2 **GB**
- 3 **LP**
- 4 **DI**

- 5 LF
- 6 LFd
- 7 BF (facet breadth)

13 Bd (ds diaphysis)

14 Bd (ds condyles)

Calcaneum (from Eiseman 1986; see Figures) (added 2005):

- 1 GL
- 2 Length proximal
- 3 GB
- 4 Smallest breadth
- 5 Proximal breadth
- 6 Proximal depth
- 7 Distal depth

Misc. Tarsal:

- 1 GB

**Metapodials:** (ruminants)

- 1 GL
- 2 GLI
- 3 LI
- 4 Bp
- 5 Dp
- 6 SD
- 7 CD
- 8 DD
- 9 Bd
- 10 Dd
- 11 Ddm
- 12 Bmedcondyle

Metapodial III Equids (from Eiseman 1986; see Figures) (added 2005):

- 1 GL
- 2 LI
- 3 SD
- 4
- 5 Bp
- 6
- 7
- 8
- 9
- 10 Bd
- 11 (Bdcondyle)
- 12 Dd
- 13
- 14

Metapodials: (Sus)

- 1 GL
- 2 LeP
- 3 Bp
- 4 B
- 5 Bd

Metapodials: (carnivores and lagomorph)

- 1 GL
- 2 Bd

Phalanx 1: (Equids) (from Eiseman 1986; see Figures) (added 2005)

- 1 GL
- 2
- 3 SD
- 4 Bp
- 5 Dp
- 6 Bd
- 7
- 8
- 9
- 10
- 11
- 12
- 13
- 14 BFd

Phalanx 1: (Equids)

- 1 GL
- 2 Bp
- 3 BFp
- 4 Dp
- 5 SD
- 6 Bd
- 7 BFd

Phalanx 1: (camelids, carnivores, lagomorphs)

- 1 GL
- 2 Bp
- 3 SD
- 4 Bd

**Phalanx 1: (Bovids and Sus)**

- 1 GLpe**
- 2 Bp**
- 3 Dp**
- 4 SD**
- 5 Bd**
- 6 Dd**
- 7 GLdorsalshaft\* (taken on dorsal surface along midline, does not include art processes)

Phalanx 2: (Equids) (from Eiseman 1986; see Figures) (changed 2005)

- 1 GL
- 2 Anterior length
- 3 SD
- 4 Bp
- 5 Dp
- 6 Bd

**Phalanx 2: (all other species)**

- 1 GL**
- 2 Bp**
- 3 Dp**
- 4 SD**
- 5 Bd**
- 6 Dd**
- 7 GLdorsalshaft\*

Distal Sesamoid of equid:

- 1 GB

Phalanx 3: (equid) (from  
Eiseman 1986; see Figures)  
(changed 2005)

- 1 Ld
- 2 GL
- 3 HP
- 4 GB
- 5 LF
- 6 BF
- 7 Distal circumference

**Phalanx 3:** (ruminants and  
Sus)

- 1 **DLS**
- 2 **Ld**
- 3 **H**
- 4 **MBS**

Petrosal:

- 1 **GL**
- 2 **GB**
- 3 **Bfen** (breadth across  
fenestrae)

Horncore (taken near base)

1. GL (anterior-posterior)
2. GB (medial-lateral)

## BIBLIOGRAPHY

- Acemoglu, Daren and James A. Robinson. 2012. *Why Nations Fail: The Origins of Power, Prosperity, and Poverty*. New York: Crown Publishers.
- Adams, Matthew J., and Margaret E. Cohen. 2013. "The 'Sea Peoples' in Primary Sources." In *The Philistines and Other "Sea Peoples" in Text and Archaeology*. Edited by Anne E. Killebrew and Gunnar Lehmann. *Archaeology and Biblical Studies* 15. Atlanta: SBL.
- Adcock, Sarah E. 2016. "Exploring the Collapse of the Hittite Empire as a Social Phenomenon." Conference presentation, Society for American Archaeology Annual Meeting, Orlando, FL, April 7, 2016.
- . 2015. "The Bigger They Are, the Harder They Fall? Exploring the Late Bronze Collapse at the Hittite Capital and a Rural Town." Conference presentation, American Schools of Oriental Research Annual Meeting, Atlanta, GA, November 19, 2015.
- Ahmed, Nafeez. 2019. "The Collapse of Civilization May Have Already Begun." VICE, November 22, 2019. [https://www.vice.com/en\\_us/article/8xwygg/the-collapse-of-civilization-may-have-already-begun](https://www.vice.com/en_us/article/8xwygg/the-collapse-of-civilization-may-have-already-begun).
- Alaura, Silvia. 2006. *"Nach Boghasköi!" Zur Vorgeschichte der Ausgrabungen in Boğazköy-Hattuša und zu den archäologischen Forschungen bis zum Ersten Weltkrieg*. Berlin: Harrasowitz.
- Albarella, Umberto. 2002. "Size Matters: How and Why Biometry is Still Important in Zooarchaeology." In *Bones and Man: Studies in Honour of Don Brothwell*. Edited by Keith Dobney and Terry P. O'Connor, 51-62. Oxford: Oxbow Books.
- Albarella, Umberto, Keith Dobney, and Peter Rowley-Conwy. 2006. "The Domestication of the Pig (*Sus scrofa*): New Challenges and Approaches." In *Documenting Domestication: New Genetic and Archaeological Paradigms*. Edited by Melinda A. Zeder, Daniel Bradley, Eve Emshwiller, and Bruce D. Smith, 209-227. Berkeley: University of California Press.
- Algaze, Guillermo. 2008. *Ancient Mesopotamia at the Dawn of Civilization: The Evolution of an Urban Landscape*. Chicago: University of Chicago Press.
- Allsen, Thomas T. 2006. *The Royal Hunt in Eurasian History*. Cambridge: Cambridge University Press.
- Altschul, Jeffrey H. 2014. Statement by the President of the Society for American Archaeology. Union of Concerned Scientists Press Conference. May 20, 2014, Washington, D.C.
- Anderson, Benedict. 2006. *Imagined Communities: Reflections on the Origin and Spread of Nationalism*. Revised ed. London: Verso.

- Andrews, Peter. 1990. *Owls, Caves, and Fossils*. London: Natural History Museum Publications.
- Anthony, David W. 2007. *The Horse, the Wheel, and Language: How Bronze-Age Riders from the Eurasian Steppes Shaped the Modern World*. Princeton: Princeton University Press.
- Arbuckle, Benjamin S. 2014a. "Inequality and the Origins of Wool Production in Central Anatolia." In *Animals and Inequality in the Ancient World*. Edited by Benjamin S. Arbuckle and Sue Ann McCarty, 211-231. Boulder: University Press of Colorado.
- . 2014b. "The Rise of Cattle Cultures in Bronze Age Anatolia." *Journal of Eastern Mediterranean Archaeology and Heritage Studies* 2(4): 277-297.
- . 2012. "Pastoralism, Provisioning, and Power at Bronze Age Achemhöyük, Turkey." *American Anthropologist* 114(3): 462-475.
- . 2006. *The Evolution of Sheep and Goat Pastoralism and Social Complexity in Central Anatolia*. PhD Dissertation, Harvard University.
- Atici, A. Levent. 2005. "Centralized or Decentralized: The Mode of Pastoral Economy at Early Bronze Age Kaman-Kalehöyük." *Kaman-Kalehöyük* 14: 119-127.
- Bar-Oz, Guy, Anna Belfer-Cohen, T. Meshveliani, N. Djakeli, and Ofer Bar-Yosef. 2008. "Taphonomy and Zooarchaeology of the Upper Paleolithic Cave of Dzudzuana, Republic of Georgia." *International Journal of Osteoarchaeology* 18: 131-151.
- Bar-Oz, Guy and T. Dayan. 2002. "'After Twenty Years': A Taphonomic Reevaluation of Nahal Hadera V, an Epipaleolithic Site on the Israeli Coastal Plain." *Journal of Archaeological Science* 29: 145-156.
- Beckman, Gary. 1999. "The City and Country in Hatti." In *Landwirtschaft im Alten Orient: ausgewählte Vorträge de XLI*. Edited by Horst Klengel and Johannes Renger, 161-169. Berlin: Dietrich Reimer Verlag.
- . 1988. "Herding and Herdsmen in Hittite Culture." In *Documentum Asiae Minoris Antiquae, Festschrift für Heinrich Otten*. Edited by Erich Neu and Christel Rüster, 33-44. Wiesbaden: Otto Harrassowitz.
- Beckman, Gary, Petra Goedegebuure, Joost Hazenbos, and Yoram Cohen. 2006. "Hittite Historical Texts I." In *The Ancient Near East: Historical Sources in Translation*. Edited by Mark W. Chavalas, 215-252. Oxford: Blackwell.
- Behrensmeyer, Anna K. 1978. "Taphonomic and Ecologic Information from Bone Weathering." *Paleobiology* 4(2): 150-162.
- Benjamin, Walter. 1968. "Theses on the Philosophy of History." In *Illuminations*. New York: Schocken Books.

- . 1999. *The Arcades Project*. Edited by Rolf Tiedemann. Cambridge: Belknap Press.
- Berthon, Rémi. 2017. “Faunal Remains of the Hittite and Byzantine Periods from the Middle Plateau.” In *Ausgrabungen und Forschungen in der westlichen Oberstadt von Hattusa II: Das Mittlere Plateau zwischen Sarikale und Yenicekale*. Edited by Andreas Schachner, 255-258. Berlin: de Gruyter.
- Binford, Lewis R. 1984. *Faunal Remains from Klasies River Mouth*. New York: Academic Press.
- . 1981. *Bones: Ancient Men and Modern Myths*. New York: Academic Press.
- Binford, Lewis R. and Jack B. Bertram. 1977. “Bone Frequencies and Attritional Processes.” In *For Theory Building in Archaeology*. Edited by Lewis R. Binford, 77-153. New York: Academic Press.
- Binford, Sally R. and Lewis R. Binford, eds. 1968. *New Perspectives in Archaeology*. Chicago: Aldine.
- Boyes, R. 2014. “Failing States Such as Syria Deserve to Fail.” *The Times*. February 19, 2014. <http://www.thetimes.co.uk/tto/opinion/columnists/article4009566.ece>.
- Brain, Charles Kimberlin. 1981. *The Hunters or the Hunted? An Introduction to African Cave Taphonomy*. Chicago: University of Chicago Press.
- Brown, James A. and John E. Kelly. 2000. “Cahokia and the Southeastern Ceremonial Complex.” In *Mounds, Modoc, and Mesoamerica: Papers in Honor of Melvin L. Fowler*. Edited by Steven R. Ahler, 469-510. Springfield: Illinois State Museum Scientific Papers, Volume XXVII.
- Bryce, Trevor. 2012. *The World of the Neo-Hittite Kingdoms: A Political and Military History*. Oxford: Oxford University Press.
- . 2005. *The Kingdom of the Hittites*. New edition. Oxford: Oxford University Press.
- . 2002. *Life and Society in the Hittite World*. Oxford: Oxford University Press.
- . 1998. *The Kingdom of the Hittites*. Oxford: Oxford University Press.
- Bulletin of the Atomic Scientists. 2020. “Closer than Ever: It Is 100 Seconds to Midnight, 2020 Doomsday Clock Announcement.” January 23, 2020. <https://thebulletin.org/doomsday-clock/>
- Burgin, James M. 2016. *Aspects of Religious Administration in the Hittite Late New Kingdom*. PhD Dissertation, The University of Chicago.

- Carrington, Damian. 2019. "Climate Crisis: 11,000 Scientists Warn of 'Untold Suffering.'" *The Guardian*. November 5, 2019.  
<https://www.theguardian.com/environment/2019/nov/05/climate-crisis-11000-scientists-warn-of-untold-suffering>
- Chantre, Ernst. 1898. *Recherches Anthropologiques Dans L'Asie Occidentale: Mission en Cappadoce 1893-1894*. Paris: Ernest Leroux Éditeur.
- Chapman, Robert. 2003. *Archaeologies of Complexity*. London: Routledge.
- Chazin, Hannah R. 2016. "The Life Assemblage: Rethinking the Politics of Pastoral Practices." In *Incomplete Archaeologies: Assembling Knowledge in the Past and Present*. Edited by Emily Miller-Bonney, Kathryn J. Franklin, and James E. Johnson, 28-47. Woodbridge, CT: Oxbow Press.
- Clarke, David L. 1968. *Analytical Archaeology*. London: Methuen and Co., Ltd.
- Cline, Eric H. 2014a. *1177 B.C.: The Year Civilization Collapsed*. Princeton: Princeton University Press.
- Cline, E. H. 2014b. "Climate Change Doomed the Ancients." *New York Times*. May 27, 2014.  
[http://www.nytimes.com/2014/05/28/opinion/climate-change-doomed-the-ancients.html?\\_r=0](http://www.nytimes.com/2014/05/28/opinion/climate-change-doomed-the-ancients.html?_r=0).
- Collins, Billie Jean. 2007. *The Hittites and Their World*. Atlanta: Society of Biblical Literature.
- . 2006. "Pigs at the Gate: Hittite Pig Sacrifice in Its Eastern Mediterranean Context." *Journal of Ancient Near Eastern Religions* 6(8): 154-188.
- . 1995. "Ritual Meals in the Hittite Cult." In *Ancient Magic and Ritual Power*. Edited by Marvin Meyer and Paul Mirecki, 77-92. Leiden: Brill.
- Crabtree, Pam J. 1990. "Zooarchaeology and Complex Societies: Some Uses of Faunal Analysis for the Study of Trade, Social Status, and Ethnicity." *Archaeological Method and Theory* 2: 155-205.
- Cunningham, Tim and Jan Driessen, eds. 2017. *Crisis to Collapse: The Archaeology of Social Breakdown*. Louvain: Presses Universitaires de Louvain.
- D'Alfonso, Lorenzo. 2020. "An Age of Experimentation: New Thoughts on the Multiple Outcomes following the Fall of the Hittite Empire after the Results of the Excavations at Niğde-Kınık Höyük (South Cappadocia)." In *Anatolia between the 13<sup>th</sup> and the 12<sup>th</sup> Century BCE*. Edited by Stefano de Martino and Elena Devecchi, 95-116. Firenze: LoGisma.
- Davis, Simon J. M. 1987. *The Archaeology of Animals*. New Haven: Yale University Press.

- Dawdy, Shannon. 2010. Clockpunk Archaeology and the Ruins of Modernity. *Current Anthropology* 51(6): 761-793.
- . 2009. “Millennial Archaeology: Locating the Discipline in the Age of Insecurity.” *Archaeological Dialogues* 16(2): 131-142.
- Dayan, Tamar, David Wool, and Daniel Simberloff. 2002. “On the Variation and Covariation of Carnivore Skulls and Teeth.” *Paleobiology* 28(4): 508-526.
- deFrance, Susan D. 2009. “Zooarchaeology in Complex Societies: Political Economy, Status, and Ideology.” *Journal of Archaeological Research* 17: 105-168.
- Diamond, Jared. 2005. *Collapse: How Societies Choose to Fail or Succeed*. New York: Viking.
- Dobney, Keith, D. Jaques, and Wim Van Neer. 2003. “Diet, Economy and Status: Evidence from the Animal Bones.” In *Excavations at Tell Brak. Volume 4: Exploring an Upper Mesopotamian Regional Centre*. Edited by Roger Mathews, 417–430. Cambridge: McDonald Institute Monographs/British Institute of Archaeology in Iraq.
- Dobney, Keith and Kevin Rielly. 1988. A Method for Recording Archaeological Animal Bones: The Use of Diagnostic Zones. *Circaea* 5(2): 79-96.
- Dörfler, Walter, Christa Herking, Reinder Nerf, Rainer Pasternak, Angela von den Driesch. 2011. “Environment and Economy in Hittite Anatolia.” In *Insights into Hittite History and Archaeology*. Edited by Hermann Genz and Dirk Paul Mielke, 99-124. Colloquia Antiqua 2. Leuven: Peeters.
- Drews, Robert. 1993, *The End of the Bronze Age: Changes in Warfare and the Catastrophe Ca. 1200 B.C.*, Princeton: Princeton University Press
- Ducos, Pierre. 1968. *L'Origine des animaux domestiques en Palestine: par Pierre Ducos*. Bordeaux: Institut de préhistoire de l'Université.
- Düring, B. S. 2011. *The Prehistory of Asia Minor: From Complex Hunter-Gatherers to Early Urban Societies*. Cambridge: Cambridge University Press.
- Earle, Timothy K. 1997. *How Chiefs Come to Power: The Political Economy in Prehistory*. Stanford: Stanford University Press.
- Edgerton, William F., and John A. Wilson. 1936. *Historical Records of Ramses III: The Texts in Medinet Habu Volumes 1 and 2, Translated with Explanatory Notes*. Studies in Ancient Oriental Civilization 12. Chicago: University of Chicago Press.
- Emery, Kitty F. 2004. “Environments of the Maya Collapse: A Zooarchaeological Perspective from the Petexbatún.” In *Maya Zooarchaeology: New Directions in Method and Theory*. Edited by Kitty F. Emery, 81-96. Los Angeles: Cotsen Institute of Archaeology at University of California, Los Angeles.

- . 1997. *The Maya Collapse: A Zooarchaeological Investigation*. PhD Dissertation, Cornell University.
- Emmerich, Roland. 2004. *The Day after Tomorrow*. DVD. Twentieth Century Fox.
- . 1996. *Independence Day*. DVD. Twentieth Century Fox.
- Faulseit, Ronald K., ed. 2016. *Beyond Collapse: Archaeological Perspectives on Resilience, Revitalization, and Transformation in Complex Societies*. Carbondale: Southern Illinois University Press.
- Feinman, Gary. M. and Joyce Marcus, eds. 1998. *Archaic States*. Santa Fe: School of American Research.
- Fischer, Franz. 1963. *Die hethitische Keramik von Boğazköy*. Boğazköy-Hattuša 4. Berlin: Verlag Gebr. Mann.
- Fischer, Bettina, Hermann Genz, Éric Jean, and Kemalettin Köroglu, eds. 2003. *Identifying Changes: The Transition from Bronze to Iron Ages in Anatolia and Its Neighbouring Regions*. Istanbul: Türk Eskiçag Bilimleri Enstitüsü.
- Flannery, Kent V. 1972. "The Cultural Evolution of Civilizations." *Annual Review of Ecology and Systematics* 3: 399-426.
- . 1968. "Archaeological Systems Theory and Early Mesoamerica." In *Anthropological Archaeology in the Americas*. Edited by Betty J. Meggers, 67-87. Washington: Anthropological Society of Washington.
- Fotiadis, Michael. 2006. "Factual Claims in Late Nineteenth Century European Prehistory and the Descent of a Modern Discipline's Ideology." *Journal of Social Archaeology* 6(1): 5-27.
- Frank, Adam. 2014. "Lessons from the Last Time Civilization Collapsed." *NPR*. August 19, 2014. <https://www.npr.org/sections/13.7/2014/08/19/341573332/lessons-from-the-last-time-civilization-collapsed>.
- Freedman, William. 1986. "Postponement and Perspectives in Shelley's 'Ozymandias.'" *Studies in Romanticism* 25(1): 63-73.
- Galant, Richard. 2020. "'World War III' Was Trending." *CNN Opinion*. January 5, 2020. <https://www.cnn.com/2020/01/05/opinions/world-war-iii-was-trending-opinion-weekly-column-galant/index.html>

- Gates Marie-Henriette. 2001. "Potmarks at Kinet Höyük and the Hittite Ceramic Industry." In *La Cilicie: Espaces et pouvoirs locaux (IIe millénaire av. J.-C. – IVe siècle ap. J.-C.)*. Edited by Eric Jean, Ali M. Dinçol, and Serra Durugönül, 137-157. Actes de la Table Ronde d'Istanbul, 2-5 novembre 1999. Istanbul : Institut Français d'Études Anatoliennes-Georges Dumézil.
- Genz, Hermann. 2013. "'No Land Could Stand Before their Arms, from Hatti ... on ...'? New Light on the End of the Hittite Empire and the Early Iron Age in Central Anatolia." In *The Philistines and Other "Sea Peoples" in Text and Archaeology*. Edited by Ann E. Killebrew and Gunnar Lehmann, 469–478. *Archaeology and Biblical Studies* 15. Atlanta: Society of Biblical Literature.
- . 2003. "The Early Iron Age in Central Anatolia." In *Identifying Changes: The Transition from Bronze to Iron Ages in Anatolia and its Neighbouring Regions*. Edited by Bettina Fischer, Hermann Genz, Éric Jean, and Kemalettin Köroglu, 179-192. Istanbul: Türk Eskiçağ Bilimleri Enstitüsü.
- Gibbon, Edward. 1996 [1776]. *The History of the Decline and Fall of the Roman Empire, Volume I*. New York: Penguin.
- Glatz, Claudia. 2009. "Empire as Network: Spheres of Material Interaction in Late Bronze Age Anatolia." *Journal of Anthropological Archaeology* 28: 127-141.
- Gopnik, Adam. 2014. "Of Hippos and Kings." *New Yorker*. March 19, 2014. <https://www.newyorker.com/news/daily-comment/of-hippos-and-kings>.
- Gorny, Ronald L. 2005. "Zippalanda Reborn?" *The Oriental Institute News and Notes* (Winter 2005): 9-12.
- . 1997. "Zippalanda and Ankuwa: The Geography of Central Anatolia in the Second Millennium B.C." *Journal of the American Oriental Society* 117: 549-557.
- Gorny, Ronald L., Gregory McMahon, Samuel Paley, and Lisa Kealhofer. 1995. "The Alişar Regional Project: 1994." *Anatolica* 21: 68-100.
- Grant, A. 1975. "Appendix B: The Use of Tooth Wear as a Guide to the Age of Domestic Animals." In *Excavations at Portchester Castle I: Roman*. Edited by B. Cunliffe, 437–450. London: Society of Antiquaries.
- Grigson, Caroline. 2008. "Culture, Ecology, and Pigs from the 5<sup>th</sup> to the 3<sup>rd</sup> Millennium B.C. around the Fertile Crescent." In *Pigs and Humans: 10,000 Years of Interaction*. Edited by U. Albarella, K. Dobney, A. Ervynck, and P. Rowley-Conwy, 83-108. Oxford: Oxford University Press.
- Harmanşah, Ömür. 2020. "Cities, the Underworld, and the Infrastructure: The Ecology of Water in the Hittite World." In *New Materialisms, Ancient Urbanisms*. Edited by Susan M. Alt and Timothy R. Pauketat, 218-244. New York: Routledge.

- Harper, Kyle. 2017. *The Fate of Rome: Climate, Disease, and the End of an Empire*. Princeton: Princeton University Press.
- Hawkins, J. Daniel. 2002. "Anatolia: The End of the Hittite Empire and After." In *Die nahöstlichen Kulturen und Griechenland an der Wende vom 2. zum 1. Jahrtausend v. Chr. Kontinuität und Wandel von Strukturen und Mechanismen kultureller Interaktion*. Edited by E.A. Braun-Holzinger and H. Matthäus, 143-151. Möhnese: Bibliopolis.
- . 1995. "The Political Geography of North Syria and South-East Anatolia in the Neo-Assyrian Period." In *Neo-Assyrian Geography*. Edited by Mario Liverani 87-100. Padova: Università di Roma 'La Sapienza' (Quaderni di Geografia Storica 5).
- . 1986. "Writing in Anatolia: Imported and Indigenous Systems." *World Archaeology* 17(3): 363-376.
- Hegel, Georg W. F. 1988 [1821]. *Introduction to the Philosophy of History*. Indianapolis: Hackett Pub. Co.
- Helmer, Daniel, Lionel Gourichon, and Emmanuelle Vila. 2007. "The Development of the Exploitation of Products from *Capra* and *Ovis* (Meat, Milk, and Fleece) from the PPNB to the Early Bronze in the Northern Near East (8700 to 2000 BC cal.)." *Anthropozoologica* 42(2): 41-69.
- Helmer, Daniel, Lionel Gourichon, Hervé Monchot, Joris Peters, and Maria Sana Segui. 2005. "Identifying Early Domestic Cattle from Pre-Pottery Neolithic Sites on the Euphrates using Sexual Dimorphism." In *The First Steps of Animal Domestication: New Archaeological Approaches. Proceedings of the 9th ICAZ Conference, Durham 2002*. Edited by Jean-Denis Vigne, Joris Peters, and Daniel Helmer, Oxbow. Oxford: 86-95.
- Herder, J. G. 2004 [1774]. "Another Philosophy of History for the Education of Mankind." In *Another Philosophy of History and Selected Political Writings*. Translated by Ioannis D. Evrigenis and Daniel Pellerin. Indianapolis: Hackett Publishing Company.
- Hollstein, Daria and Geraldine Middea. 2014. "The Faunal Remains from the Square Building Horizon in the Valley West of Sarıkale, Boğazköy- Hattuşa." In *Ausgrabungen und Forschungen in der Westlichen Oberstadt von Hattuşa I*. Edited by Andreas Schachner and Jürgen Seeher, 147-215. Boğazköy- Hattuşa Ergebnisse der Ausgrabungen 24. Berlin: Deutschen Archaologischen Instituts.
- Hoffner, Harry A. 1974. *Alimenta Hethaeorum: Food Production in Hittite Asia Minor*. American Oriental Series Vol. 55. New Haven: American Oriental Society.
- Hongo, Hitomi. 2004. "Transition from the Bronze Age to the Iron Age in Central Anatolia: A View from Faunal Remains from Kaman-Kalehöyük." *Kaman-Kalehöyük* 13: 121-131.

- . 1996. *Patterns of Animal Husbandry in Central Anatolia from the Second Millennium B.C. through the Middle Ages: Faunal Remains from Kaman-Kalehöyük, Turkey*. PhD Dissertation, Harvard University.
- Hrozný, Bedřich. 1917. *Die Sprache der Hethiter*. Leipzig: J. C. Hinrichs'sche Buchhandlung.
- “Hubert Robert: Painter of Ruins-At the Louvre after the French Revolution.” N.d.  
<http://omeka.wellesley.edu/piranesi-rome/exhibits/show/hubert-robert/postrelouvre>
- Hutter, Manfred. 1997. “Religion in Hittite Anatolia. Some Comments on ‘Volkert Haas: Geschichte der Hethitischen Religion.’” *Numen* 44(1): 74-90.
- Isaakidou, Valasia. 2011. “Gardening with Cows: Hoe and Plough in Prehistoric Europe. In *The Dynamics of Neolithisation in Europe: Studies in Honour of Andrew Sherratt*. Edited by Erick Robinson, Sarah Viner, and Angelos Hadjikoymis, 90-112. Oxford: Oxbow.
- . 2006. “Ploughing with Cows: Knossos and the Secondary Products Revolution.” In *Animals in the Neolithic of Britain and Europe: Neolithic Studies Group Seminar Papers* 7. Edited by Dale Serjeantson and David Field, 95-112. Oxford: Oxbow Books.
- Johnson, Scott A. J. 2016. *Why Did Ancient Civilizations Fail?* New York: Routledge.
- Kaniewski David, Joël Guiot, and Elise Van Campo. 2015. “Drought and Societal Collapse 3200 Years Ago in the Eastern Mediterranean: A Review.” *WIREs Climate Change* 6(4): 369-382.
- Kaniewski, David, Elise Van Campo, Joël Guiot, Sabine Le Burel, Thierry Otto, and Cecile Baeteman. 2013. “Environmental Roots of the Late Bronze Age Crisis.” *PLoS One* 8(8): e71004.
- Kealhofer, Lisa and Peter Grave. 2011. “The Iron Age on the Central Anatolian Plateau.” In *Handbook of Ancient Anatolia*. Edited by Sharon R. Steadman and Gregory McMahon, 415-442. Oxford: Oxford University Press.
- Kelly, Lucretia S. 2000. “Patterns of Faunal Exploitation at Cahokia.” In *Cahokia: Domination and Ideology in the Mississippian World*. Edited by Timothy R. Pauketat and Thomas E. Emerson, 69-88. Lincoln: University of Nebraska Press.
- Kelly, Lucretia S. and John E. Kelly. 2007. “Swans in the American Bottom during the Emergent Mississippian and the Mississippian.” *Journal of the Illinois Archaeological Survey* 15/16: 112-141.
- Kemp, Luke. 2019. “Are We on the Road to Civilisation Collapse?” BBC Future. BBC. February 18, 2019. <https://www.bbc.com/future/article/20190218-are-we-on-the-road-to-civilisation-collapse>.

- Kolata, Alan L. 2006. "Before and After Collapse: Reflections on the Regeneration of Social Complexity." In *After Collapse: The Regeneration of Complex Societies*. Edited by Glenn M. Schwartz and John J. Nichols, 208-221. Tucson: University of Arizona Press.
- Korbel, Günther. 1987. *Die spätbronzezeitliche Keramik von Norşuntepe*. Mitteilungen no. 4. Hannover: Institut für Bauen und Planen in Entwicklungsländern.
- Lauterwasser, David B. 2017. "The Collapse of Global Civilization Has Begun." November 14, 2017. <https://medium.com/@FeunFooPermaKra/the-collapse-of-global-civilization-has-begun-b527c649754c>.
- Lehner, Joseph William. 2015. *Cooperation, the Craft Economy, and Metal Technology during the Bronze and Iron Ages in Central Anatolia*. PhD Dissertation, University of California Los Angeles.
- Lev-Tov, Justin and Susan D. deFrance. 2010. "Animals and Complexity: How Zooarchaeologists Contribute to the Study of Complex Society in the New and Old Worlds." In *Anthropological Approaches to Zooarchaeology: Complexity, Colonialism, and Animal Transformations*. Edited by Douglas V. Campana, Pam J. Crabtree, Justin Lev-Tov, and Susan D. deFrance, x-xii. Oxford: Oxbow.
- Lévi-Strauss, Claude. 1963. *Totemism*. Translated by Rodney Needham. Boston: Beacon Press.
- Lucas, Gavin. 2013. "Ruins." In *The Oxford Handbook of the Archaeology of the Contemporary World*. Edited by P. Graves-Brown, Rodney Harrison, and Angela Piccini, 192-203. Oxford: Oxford University Press.
- Lyman, R. Lee. 2008. *Quantitative Paleozoology*. Cambridge: Cambridge University Press.
- . 1994. *Vertebrate Taphonomy*. Cambridge: Cambridge University Press.
- Maltby, J. M. 1985. "Patterns in Faunal Assemblage Variability." In *Beyond Domestication in Prehistoric Europe: Investigations in Subsistence Archaeology and Social Complexity*. Edited by G. Barker and C. Gamble, 33-74. London: Academic Press.
- Marchand, Suzanne L. 1996. *Down from Olympus: Archaeology and Philhellenism in Germany, 1750-1970*. Princeton: Princeton University Press.
- Marcus, J. S. 2016. "The Louvre and National Gallery Fete 'Robert of the Ruins.'" *The Wall Street Journal*. February 26, 2016. <https://www.wsj.com/articles/the-louvre-and-national-gallery-fete-robert-of-the-ruins-1456517508>.
- Marean, C. W. 1991. "Measuring the Post-Depositional Destruction of Bone in Archaeological Assemblages." *Journal of Archaeological Science* 18: 677-694.
- Masco, Joseph. 2008. "'Survival Is Your Business': Engineering Ruins and Affect in Nuclear America." *Current Anthropology* 23(2): 361-395.

- McAnany, Patricia Ann and Norman Yoffee, eds. 2010. *Questioning Collapse: Human Resilience, Ecological Vulnerability, and the Aftermath of Empire*. New York: Cambridge University Press.
- Meadow, Richard H. 1999. "The Use of Size Index Scaling Techniques for Research on Archaeozoological Collections from the Middle East." In *Historia Animalium ex Ossibus: Beiträge auf Paläoanatomie, Archäologie, Ägyptologie, Ethnologie und Geschichte der Tiermedizin*. Edited by Cornelia Becker, Henriette Manhart, Joris Peters, and Jorg Schibler, 285-300. Rahden/Westf.: Verlag Marie Leidorf.
- Meadow, Richard H. 1978. "Bonocode—A System of Numerical Coding for Faunal Data from Near Eastern Sites." In *Approaches to Faunal Analysis in the Middle East*. Edited by Richard H. Meadow and Melinda A. Zeder, 169-186. Peabody Museum Bulletin 2. Cambridge: Harvard University Press.
- Middleton, Guy. 2017a. "The Show Must Go On: Collapse, Resilience, and Transformation in 21<sup>st</sup> Century Archaeology." *Reviews in Anthropology* 46(2-3): 78-105.
- . 2017b. *Understanding Collapse: Ancient History and Modern Myths*. Cambridge: Cambridge University Press.
- Mielke, Dirk Paul, Ulf-Dietrich Schoop, and Jürgen Seeher, eds. 2006. *Structuring and Dating in Hittite Archaeology*. Byzas 4. Istanbul: Zero Prod.
- Miller, James G. 1965. "Living Systems: Basic Concepts." *Behavioral Science* 10(3): 193-237.
- Miller, Naomi F., Melinda A. Zeder, Susan R. Arter. 2009. "From Food and Fuel to Farms and Flocks: The Integration of Plant and Animal Remains in the Study of the Agropastoral Economy at Gordion, Turkey." *Current Anthropology* 50(6): 915-924.
- Molteni, Megan. 2020. "Could China's New Coronavirus Become a Global Epidemic?" *Wired*. January 22, 2020. <https://www.wired.com/story/could-chinas-new-coronavirus-become-a-global-epidemic/>.
- Morgan, Lewis. H. 1877. *Ancient Society*. New York: Henry Holt.
- Murray, Sarah. 2017. *The Collapse of the Mycenaean Economy: Imports, Trade, and Institutions, 1300-700 BCE*. New York: Cambridge University Press.
- Müller-Karpe, Andreas. 2002. "Kuşaklı-Sarissa: A Hittite Town in the 'Upper Land.'" In *Recent Developments in Hittite Archaeology and History. Papers in Memory of Hans G. Güterbock*. Edited by K. Aslihan Yener and Harry A. Hoffner, Jr., with the assistance of Simrit Dhesi, 145-155. Winona Lake, IN: Eisenbrauns.
- Oates, Joan, Augusta McMahon, Philip Karsgaard, Salam al-Quntar, and Jason Ur. 2007. "Early Mesopotamian Urbanism, A New View from the North." *Antiquity* 81: 585-600.

- O'Day, Sharyn Jones, Wim Van Neer, Anton Ervynck, eds. 2004. *Behaviour Behind Bones: The Zooarchaeology of Ritual, Religion, Status, and Identity*. Proceedings of the 9<sup>th</sup> ICAZ Conference Book 1. Oxford: Oxbow Books.
- Oettinger, Norbert. 2002. "Indogermanische Sprachträger lebten schon im 3. Jahrtausend v. Chr. in Kleinasien: Die Ausbildung der anatolischen Sprachen." In *Die Hethiter und ihr Reich: Das Volk der 1000 Götter*. Edited by Helga Willinghöffer and Ute Hasekamp, 50-55. Stuttgart: Theiss.
- Omura, Sachihiko. 2011. "Kaman-kalehöyük Excavations in Central Anatolia." In *The Oxford Handbook of Ancient Anatolia: 10,000 – 323 B.C.* Edited by Sharon R. Steadman and Gregory McMahon, 1095-1111. Oxford: Oxford University Press.
- Orton, David C. 2011. "Taphonomy and Interpretation: An Analytical Framework for Social Zooarchaeology." *International Journal of Osteoarchaeology* 22: 320-337.
- Pauketat, Timothy R. 2007. *Chieftoms and Other Archaeological Delusions*. Lanham: AltaMira Press.
- . 2004. *Ancient Cahokia and the Mississippians*. Cambridge: Cambridge University Press.
- Payne, Sebastian. 1973. "Kill-off Patterns in Sheep and Goats: The Mandibles from Asvan Kale." *Anatolian Studies* 23: 281-303.
- Peterson, Larry C. and Gerald G. Haug. 2005. "Climate and the Collapse of Maya Civilization: A Series of Multi-Year Droughts Helped to Doom an Ancient Culture." *American Scientist* 93: 322-329.
- Popko, Maciej. 2000. "Zippalanda and Ankuwa Once More." *Journal of the American Oriental Society* 120(3): 445-448.
- Postgate, J. Nicholas. 2007. "The Ceramics of Centralisation and Dissolution: A Case Study from Rough Cilicia." *Anatolian Studies* 57: 141-150.
- Railey, Jimmy A. and Richard Martin Reycraft, eds. 2008. *Global Perspectives on the Collapse of Complex Systems*. Albuquerque: Maxwell Museum of Anthropology.
- Rappaport, Roy A. 1977. "Maladaptation in Social Systems." In *Evolution in Social Systems, Proceedings of a Meeting of the Research Seminar in Archaeology and Related Subjects Held at the Institute of Archaeology, London University*. Edited by J. Friedman and M. Rowlands, 49-71. London: Duckworth.
- Redding, Richard. 1984. "Theoretical Determinants of a Herder's Decisions: Modeling Variation in the Sheep/Goat Ratio." In *Animals and Archaeology, Vol. 3, Early Herders and Their Flocks*. Edited by Juliet Clutton-Brock and Caroline Grigson, 223-241. British Archaeology Review International Series 202. Oxford: British Archaeology Review.

- Reitz, Elizabeth J. and Elizabeth S. Wing. 2008. *Zooarchaeology*. Second edition. Cambridge: Cambridge University Press.
- Renfrew, Colin. 1987. *Archaeology and Language: The Puzzle of Indo-European Origins*. Cambridge: Cambridge University Press.
- . 1984. *Approaches to Social Archaeology*. Cambridge: Harvard University Press.
- Rizzetto, Mauro, Pam J. Crabtree, and Umberto Albarella. 2017. “Livestock Changes at the Beginning and End of the Roman Period in Britain: Issues of Acculturation, Adaptation, and ‘Improvement.’” *European Journal of Archaeology* 20(3): 535-556.
- Robbins, Manuel. 2001. *Collapse of the Bronze Age: The Story of Greece, Troy, Israel, Egypt, and the Peoples of the Sea*. San Jose: Authors Choice Press.
- Robert, Hubert. 1789. *The Monuments of Paris*. Power Corporation of Canada Art Collection.
- Ross, Jennifer C. 2010. “Çadır Höyük: The Upper South Slope 2006-2009.” *Anatolica* 36: 67-87.
- Ross, Jennifer C., Sharon R. Steadman, Gregory McMahon, Sarah E. Adcock, and Joshua W. Cannon. 2019a. “When the Giant Falls: Endurance and Adaptation at Çadır Höyük in the Context of the Hittite Empire and Its Collapse.” *Journal of Field Archaeology* 44(1): 19-39.
- Ross, Jennifer C., Gregory McMahon, Yağmur Heffron, Sarah E. Adcock, Sharon R. Steadman, Benjamin S. Arbuckle, Alexia Smith, and Madelynn von Baeyer. 2019b. “Anatolian Empires: Local Experiences from the Hittites to the Phrygians.” *Journal of Eastern Mediterranean Archaeology and Heritage Studies* 7(3): 299-320.
- Rossel, Stine. 2007. *The Development of Productive Subsistence Economies in the Nile Valley: Zooarchaeological Analysis at El-Mahâsna and South Abydos, Upper Egypt*. PhD Dissertation, Harvard University.
- Russell, Nerissa. 2011. *Social Zooarchaeology: Humans and Animals in Prehistory*. Cambridge: Cambridge University Press.
- Russell, Nerissa, and Louise Martin. 2005. “The Çatalhöyük Mammal Remains. In *Inhabiting Çatalhöyük: Reports from the 1995-1999 Seasons*. Edited by Ian Hodder, 33-98. McDonald Institute Monographs. Cambridge: McDonald Institute for Archaeological Research.
- Sagona, A. G. and Paul E. Zimansky. 2009. *Ancient Turkey*. London: Routledge.
- Sandars, Nancy K. 1985. *The Sea Peoples: Warriors of the Ancient Mediterranean*. Revised ed. London: Thames and Hudson.

- Schachner, Andreas. 2020. "The 14<sup>th</sup> and 13<sup>th</sup> Centuries in the Hittite Capital City Hattuša: A (Re-)Assessment." In *Anatolia Between the 13<sup>th</sup> and 12<sup>th</sup> Century BCE*. Edited by Stefano de Martino and Elena Devecchi, 381-410. Firenze: LoGisma.
- . 2015. "Die Ausgrabungen in der Unterstadt von Hattusa (2009-2014): Erste Vorläufige Ergebnisse." In *Sacred Landscapes of Hittites and Luwians: Proceedings of the International Conference in Honor of Franca Peccholi Daddi*. Edited by Anacleto D'Agostino, Valentina Orsi, and Giulia Torri, 67-81. Firenze: Firenze University Press.
- . 2014. "Die Ausgrabungen in Boğazköy-Hattuša 2013." *Archäologischer Anzeiger* 2014: 31-86.
- . 2012. "Die Ausgrabungen in Boğazköy-Hattuša 2011." *Archäologischer Anzeiger* 2012: 85-137.
- . 2011. *Hattuscha. Auf der Suche nach dem sagenhaften Großreich der Hethiter*. Munich: C.H. Beck.
- . 2010. "Die Ausgrabungen in Boğazköy-Hattuša 2009." *Archäologischer Anzeiger* 2010:161-221.
- Schaffner, Franklin J. and Pierre Boule. 1968. *Planet of the Apes*. Twentieth Century Fox.
- Schiffer, Michael B. 1987. *Formation Processes of the Archaeological Record*. Albuquerque: The University of New Mexico Press.
- Schoop, Ulf-Dietrich. 2006. "Dating the Hittites with Statistics: Ten Pottery Assemblages from Boğazköy-Hattuša." In *Structuring and Dating in Hittite Archaeology*. Edited by Dirk P. Mielke, Ulf-Dietrich Schoop, and Jürgen Seeher, 215-240. Istanbul: Zero Prod.
- Schwartz, Glenn M. 2006. "From Collapse to Regeneration." In *After Collapse: The Regeneration of Complex Societies*. Edited by Glenn Schwartz and John Nichols, 3-17. Tucson: University of Arizona Press.
- Schwartz, Glenn M. and John J. Nichols, Eds. 2006. *After Collapse: The Regeneration of Complex Societies*. Tucson: University of Arizona Press.
- Seeher, Jürgen. 2011. "The Plateau: The Hittites." In *The Oxford Handbook of Ancient Anatolia*. Edited by Sharon R. Steadman and Gregory McMahon, 376-392. Oxford: Oxford University Press.
- . 2002. *Hattusha-guide: A Day in the Hittite Capital*. 2<sup>nd</sup> revised ed. Istanbul: Ege Yayınları.
- . 2001. "Die Zerstörung der Stadt Hattuša." In *Akten des IV. Internationalen Kongresses für Hethitologie. Würzburg, 4.-8. Oktober 1999*. Edited by G. Wilhelm, 626-634. Studien zu den Boğazköy-Texten 45. Wiesbaden: Harrassowitz.

- . 1995. “Forty Years in the Capital of the Hittites.” *Biblical Archaeologist* 58(2) (*A Tribute to Peter Neve*): 63-67.
- Service, Elman R. 1975. *Origins of the State and Civilization: The Process of Cultural Evolution*. New York: Norton.
- Sharlach, Tonia M. 2014. *Provincial Taxation and the Ur III State*. Leiden: Brill.
- Sherratt, S. 1998. “‘Sea Peoples’ and the Economic Structure of the Late Second Millennium in the Eastern Mediterranean.” In *Mediterranean Peoples in Transition: Thirteenth to Early Tenth Centuries BCE*. Edited by Seymour Gitin, Amihai Mazar, and Ephraim Stern, 292-313. Jerusalem: Israel Exploration Society.
- Silver, I. A. 1963. “The Ageing of Domestic Animals.” In *Science in Archaeology*. 2nd edition. Edited by Don Brothwell and Eric Higgs, 283-302. London: Thames and Hudson.
- Singer, Itamar. 2009. “‘In Hattuša the Royal House Declined’ Royal Mortuary Cult in 13<sup>th</sup> Century Hatti.” In *Central-North Anatolia in the Hittite Period. New Perspectives in Light of Recent Research*. Acts of the International Conference Held at the University of Florence (7-9 February 2007). Edited by Franca Pecchioli Daddi, Giulia Torri, and Carlo Corti, 169-191. Studia Asiana 5. Rome: Herder.
- . 2000. “New Evidence on the End of the Hittite Empire.” In *The Sea Peoples and Their World: A Reassessment*. Edited by E. D. Oren, 21-33. Philadelphia: University of Pennsylvania.
- Somerville, Andrew D., Nawa Sugiyama, Linda R. Manzanilla, and Margaret J. Schoeninger. 2016. “Animal Management at the Ancient Metropolis of Teotihuacan, Mexico: Stable Isotope Analysis of Leporid (Cottontail and Jackrabbit) Bone Mineral.” *PLoS ONE* 11(8): e0159982.
- Spinney, Laura. 2018. “End of Days: Is Western Civilisation on the Brink of Collapse?” *New Scientist*. January 17, 2018. <https://www.newscientist.com/article/mg23731610-300-end-of-days-is-western-civilisation-on-the-brink-of-collapse/>.
- Steadman, Sharon R. 2011. “The Early Bronze Age on the Plateau.” In *Handbook of Ancient Anatolia*. Edited by Sharon R. Steadman and Gregory McMahon, 229-259. Oxford: Oxford University Press.
- Steadman, Sharon R., Gregory McMahon, Jennifer C. Ross, Jeffrey D. Geyer, Benjamin S. Arbuckle, and Madelynn von Baeyer. 2013. “The 2009 and 2012 Seasons of Excavation at Çadır Höyük on the Anatolian North Central Plateau.” *Anatolica* 39: 113-167.
- Steadman, Sharon R., and Gregory McMahon. 2015. “Recent Work (2013-2014) at Çadır Höyük on the North Central Anatolian Plateau.” In *The Archaeology of Anatolia: Recent Discoveries (2011–2014), Volume I*. Edited by Sharon R. Steadman and Gregory McMahon, 69–97. Newcastle-upon-Tyne: Cambridge Scholars Publishing.

- Steadman, Sharon R., Gregory McMahon, Jennifer C. Ross, Marica Cassis, T. Emre Şerifoğlu, Benjamin S. Arbuckle, Sarah E. Adcock, Songül Alpaslan Roodenberg, Madelynn von Baeyer, and Anthony J. Lauricella. 2015. "The 2013 and 2014 Excavation Seasons at Çadır Höyük on the Anatolian North Central Plateau." *Anatolica* 41: 87-123.
- Steadman, Sharon R., T. Emre Şerifoğlu, Gregory McMahon, Stephanie Selover, Laurel D. Hackley, Burcu Yıldırım, Anthony J. Lauricella, Benjamin S. Arbuckle, Sarah E. Adcock, Katie Tardio, Emrah Dinç, and Marica Cassis. 2017. "Recent Discoveries (2015-2016) at Çadır Höyük on the North Central Plateau." *Anatolica* 43: 204-250.
- Steadman, Sharon R., Gregory McMahon, and Jennifer C. Ross. 2007. "The Late Chalcolithic at Çadır Höyük in Central Anatolia." *Journal of Field Archaeology*. 34(4): 385-406.
- Steadman, Sharon R., Jennifer C. Ross, Gregory McMahon, and Ronald L. Gorny. 2008. "Excavations on the North-Central Plateau: The Chalcolithic and Early Bronze Age Occupation at Çadır Höyük." *Anatolian Studies* 58: 47-86.
- Steele, Teresa E. 2015. "The Contributions of Animal Bones from Archaeological Sites: The Past and Future of Zooarchaeology." *Journal of Archaeological Science* 56: 158-176.
- Stein, Gil J. 2002. "Food Preparation, Social Context, and Ethnicity in a Prehistoric Mesopotamian Colony." In *The Menial Art of Cooking: Archaeological Studies of Cooking and Food Preparation*. Edited by Sarah R. Graff and Enrique Rodriguez-Alegria, 47-63. Boulder: The University Press of Colorado.
- . 2001. "Indigenous Social Complexity at Hacinebi (Turkey) and the Organization of Uruk Colonial Contact." In *Uruk Mesopotamia and Its Neighbors*. Edited by Mitchell S. Rothman, 265-305. Santa Fe: School of American Research Press.
- . 1987. "Regional Economic Integration in Early State Societies: Third Millennium BC Pastoral Production at Gritille, Southeast Turkey." *Paléorient* 13(2): 101-111.
- Steinkeller, Piotr. 1987. "The Administrative and Economic Origin of the Ur III State: The Core and the Periphery." In *The Organization of Power and Aspects of Bureaucracy in the Ancient Near East*. Edited by McGuire Gibson and Robert D. Biggs, 19-41. Studies in Ancient Oriental Civilization No. 46. Chicago: Oriental Institute.
- Storey, Rebecca and Glenn R. Storey. 2017. *Rome and the Classic Maya: Comparing the Slow Collapse of Civilizations*. New York: Routledge.
- Summers, Geoffrey. 2008. "Periodisation and Terminology in the Central Anatolian Iron Age." *Ancient Near Eastern Studies* 45: 202-217.
- . 2006. "Aspects of Material Culture at the Iron Age Capital on the Kerkenes Dağ in Central Anatolia." *Ancient Near Eastern Studies* 43: 164-202.
- Süel, Mustafa. *Ortaköy/Şapinuwa: Bir Hitit Başkenti*. Ankara: Uyum Ajans.

- Tainter, Joseph A. 2006. "The Archaeology of Overshoot and Collapse." *Annual Review of Anthropology* 35: 59-74.
- . 1988. *The Collapse of Complex Societies*. Cambridge: Cambridge University Press.
- Uerpmann, Hans-Peter. 1973. "Animal Bone Finds and Economic Archaeology: A Critical Study of 'Osteoarchaeological' Method." *World Archaeology* 4: 307-322.
- Uerpmann, Margarethe, and Hans-Peter Uerpmann. 1994. "Animal Bone Finds from Excavation 520 at Qala'at al-Bahrain." In *Qala'at al-Bahrain. Volume 1. The Northern City Wall and the Islamic Fortress*. Edited by Flemming Højlund and H. Hellmuth Anderson, 417-444. Aarhus: Jutland Archaeological Society Publications 30.1.
- United Nations. 2019. "Nature's Dangerous Decline 'Unprecedented'; Species Extinction Rates 'Accelerating.'" May 2019.  
<https://www.un.org/sustainabledevelopment/blog/2019/05/nature-decline-unprecedented-report/>.
- Van de Mieroop, Marc. 2007. *A History of the Ancient Near East ca. 3000-323 BC*. 2nd ed. Malden, MA: Blackwell.
- von den Driesch, Angela. 1976. *A Guide to the Measurement of Animal Bones from Archaeological Sites*. Cambridge: Peabody Museum Press.
- von den Driesch, Angela and Joachim Boessneck. 1981. *Reste von haus- und jagdtieren aus der Unterstadt von Bogazkoy-Hattusa: Grabungen 1958-1977*. Berlin: Gebr. Mann Verlag.
- von den Driesch, Angela and Nadja Pöllath. 2004. *Vor- und Frühgeschichtliche Nutztierhaltung und Jagd auf Büyükkaya in Boğazköy-Hattuša, Zentralanatolien*. Mainz am Rhein: Verlag Philipp von Zabern.
- von den Driesch, Angela. and Nadja Pöllath. 2003. "Changes from Late Bronze Age to Early Iron Age Animal Husbandry as Reflected in the Faunal Remains from Büyükkaya/Boğazköy-Hattuša." In *Identifying Changes: The Transition from Bronze to Iron Ages in Anatolia and its Neighbouring Regions*. Edited by Bettina Fischer, Hermann Genz, Éric Jean, and Kemalettin Köroglu, 295-99. Istanbul: Türk Eskiçağ Bilimleri Enstitüsü.
- Watson, J. P. N. 1979. "The Estimation of the Relative Frequencies of Mammalian Species: Khirokitia, 1972." *Journal of Archaeological Science* 6(2): 127-137.
- Wattenmaker, Patricia. 1998. *Household and State in Upper Mesopotamia: Specialized Economy and the Social Uses of Goods in an Early Complex Society*. Washington: Smithsonian Institution Press.

- Weinstock, Jaco. 2000. "Osteometry as a Source of Refined Demographic Information: Sex-Ratios of Reindeer, Hunting Strategies, and Herd Control in the Late Glacial Site of Stellmoor, Northern Germany." *Journal of Archaeological Science* 27(12): 1187-1195.
- Weiss, Harvey, ed. 2017. *Megadrought and Collapse: From Early Agriculture to Angkor*. Oxford: Oxford University Press.
- Weiss, Harvey. 2015. "Megadrought, Collapse, and Resilience in Late 3rd Millennium BC Mesopotamia." In *2200 BC—A Climatic Breakdown as a Cause for the Collapse of the Old World?* Edited by Harald Meller, Helge Wolfgang Arz, Reinhard Jung, and Roberto Risch, 35-52. Halle (Saale): Landesamt für Denkmalpflege und Archäologie Sachsen-Anhalt, Landesmuseum für Vorgeschichte.
- . 2000. "Beyond the Younger Dryas: Collapse as Adaptation to Abrupt Climate Change in Ancient West Asia and the Eastern Mediterranean." In *Environmental Disaster and the Archaeology of Human Response*. Edited by G. Bawden and R. Reyecraft, 75-98. Albuquerque: University of New Mexico.
- . 1997. "Late Third Millennium Abrupt Climate Change and Social Collapse in West Asia and Egypt." In *Third Millennium BC Climate Change and Old World Collapse*. Edited by H. Nüzhet Dalfes, George Kukla, and Harvey Weiss. Berlin: Springer.
- Weiss, Harvey and Raymond S. Bradley. 2001. "What Drives Societal Collapse?" *Science* 291(5504): 609-610.
- Wengrow, David. 2010. *What Makes Civilization?: The Ancient Near East and the Future of the West*. Oxford: Oxford University Press.
- Wilkinson, Tony J., McGuire Gibson, John H. Christiansen, Magnus Widell, David Schloen, Nicholas Kouchoukos, Christopher Woods, John Sanders, Kathy-Lee Simunich, Mark Altaweel, Jason A. Ur, Carrie Hritz, Jacob Lauinger, Tate Paulette, and Jonathan Tenney. 2007. "Modeling Settlement Systems in a Dynamic Environment: Case Studies from Mesopotamia." In *Model Based Archaeology*. Edited by Timotyh Kohler and Sander E. van der Leeuw, 175-208. Santa Fe, New Mexico: School for Advanced Research Press.
- Wright, Henry T. and Gregory A. Johnson. 1975. "Population, Exchange, and Early State Formation in Southwestern Iran." *American Anthropologist* 77(2): 267-289.
- Yakar, J. 2006. "Dating the Sequence of the Final Destruction/Abandonment of LBA Settlements: Towards a Better Understanding of Events that Led to the Collapse of the Hittite Kingdom." In *Strukturierung und Datierung in der hethitischen Archäologie/Structure and Dating in Hittite Archaeology*. Edited by Dirk Paul Mielke, Ulf-Dietrich Schoop, and Jürgen Seeher, 33-51. Istanbul: BYZAS 4.
- Yoffee, Norman. 2005. *Myths of the Archaic State: Evolution of the Earliest Cities, States, and Civilizations*. Cambridge: Cambridge University Press.

- . 1988. “Orienting Collapse.” In *The Collapse of Ancient States and Civilizations*. Edited by Norman Yoffee and George L. Cowgill, 1-19. Tucson: University of Arizona Press.
- Yoffee, Norman and G. L. Cowgil, eds. 1988. *The Collapse of Ancient States and Civilizations*. Tucson: University of Arizona Press.
- Yuhas, Alan. 2015. “Great Blue Hole off Belize Yields New Clues to Fall of Mayan Civilisation.” *The Guardian*. January 3, 2015.  
<http://www.theguardian.com/world/2015/jan/03/great-blue-hole-belize-clues-fall-mayan-civilisation>.
- Zeder, Melinda A. 2012. “The Domestication of Animals.” *Journal of Anthropological Research* 68(2): 161-190.
- . 2008. “Animal Domestication in the Zagros: An Update and Directions for Future Research.” In *Archaeozoology of the Near East VIII*. Edited by Emmanuelle Vila, Lionel Gourichon, A. Choyke, and H. Buitenhuis, 243-278. Lyon: Maison de l’Orient et de la Méditerranée.
- . 2006. “Reconciling Rates of Long Bone Fusion and Tooth Eruption Wear in Sheep (*Ovis*) and Goat (*Capra*).” In *Ageing and Sexing Animals from Archaeological Sites*. Edited by D. Ruscillo, 87-118. Oxford: Oxbow Press.
- . 2003. “Food Provisioning in Urban Societies: A View from Northern Mesopotamia.” In *The Social Construction of Ancient Cities*. Edited by Monica Smith, 156-183. Washington: Smithsonian Press.
- . 2001. “A Metrical Analysis of a Collection of Modern Goats (*Capra hircus aegargus* and *C. h. hircus*) from Iran and Iraq: Implications for the Study of Caprine Domestication.” *Journal of Archaeological Science* 28: 61-79.
- . 1994. “Of Kings and Shepherds: Specialized Economy in Ur III Mesopotamia.” In *Chiefdoms and Early States in the Near East: The Organizational Dynamics of Complexity*. Edited by Gil J. Stein and Mitchell Rothman, 175–191. Monographs in World Archaeology 18. Madison: Prehistory Press.
- . 1991. *Feeding Cities: Specialized Animal Economy in the Ancient Near East*. Washington: Smithsonian Institution Press.
- . 1988. “Understanding Urban Process through the Study of Specialized Subsistence Economy in the Near East.” *Journal of Anthropological Archaeology* 7(1): 1-55.
- Zeder, Melinda A. and Susan R. Arter. 1994. “Changing Patterns of Animal Utilization at Ancient Gordion.” *Paléorient* 20.2: 105-118.