The Ertebølle Faunal Economy and the Transition to Agriculture in Southern Scandinavia

By

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Abstract

The transition around 3950 B.C. in northern Europe from the Mesolithic Ertebølle Culture (EBK) to the Neolithic Funnel Beaker Culture (TRB) is one of the last transitions from hunter-gatherers to agriculturalists in Europe. The mechanisms of and the reasons for the transition, however, are not fully understood. This dissertation represents an effort to help clarify the situation through the study of three late EBK faunal assemblages from Northwest Zealand, Denmark, and the study of the fauna from one of the transitional shell middens, Havnø, Jutland, Denmark, which possibly represents the largest early TRB assemblage. In addition, the new data were assessed in conjunction with previous scholarly works in order to build a model of faunal economy variability in the EBK and TRB. To accomplish these goals I relied on three approaches: 1) traditional zooarchaeological analysis, 2) the analysis of carbon and nitrogen isotopic ratios in bone collagen, and 3) comparative analysis of published EBK and early TRB faunal assemblages.

My big questions included: 1) What can the data tell us about human behavior and the local environment in Denmark at the EBK-TRB transition? 2) How variable are EBK faunal assemblages and what does this variability mean? 3) How well do the new and aggregate data fit accepted views of EBK resource use? 4) How much of a change in animal resource exploitation is apparent during the transition, and what explanatory implications does this have for the origins of agriculture in the region?

From this research I report several broad conclusions. First, significant flexibility of Ertebølle groups in their use of available resources and ability to weather all but a total environmental catastrophe means that environmental change alone could not have compelled the adoption of agriculture. Second, evidence indicates a more abrupt transition to agriculture, with animal husbandry in strong evidence even at a transitional shell midden site. Finally, I argue for strong and nested regionality in faunal resource use in the EBK, in part independent of environmental variability and for the possibility of such regionality in the earliest Neolithic as well.

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Map: Archaeological Sites Mentioned in the Text

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Chapter 1: Introduction

Introduction

The transition in Southern Scandinavia from the Mesolithic Ertebølle culture (EBK) to the Neolithic Funnel Beaker culture or Tragtbægerkultur (TRB) is one of the last transitions from hunter-gatherers to agriculturalists in Europe, occurring around 3950 B.C. (Price and Gebauer 2005). Possibly due to this late transition, this region has attracted the interest of scholars for well over a century resulting in very considerable scholarship and a nearly unequalled corpus of archaeological data. Questions remain however. It seems the more we know, the less scholars can agree on the ultimate reasons for the transition in the region.

At present, three major issues surround the transition to agriculture in this region: how long the transition took, the reason for its occurrence, and who was involved (Bonsall et al. 2002; Fischer 2002; Johansen 2006; Klassen 1999; Larsson 2007; Madsen 1986; Petersson 1999; Price et al 1995; Price and Noe-Nygaard 2009; Rowley-Conwy 2004; Schulting 2010; Sørensen and Karg 2012). This dissertation will focus on the reasons for the transition, particularly on subsistence practices during the late Mesolithic, and uses these data as a framework for understanding the earliest agriculture in the region. Faunal remains are key in understanding the EBK and TRB economies as well as the transition due to their frequent recovery and variable uses for Stone Age people. In fact, at the few known transitional EBK and TRB sites, evidence of animal economy is intriguing, as there appears to be only a minor shift in faunal resources concurrent with the initial inclusion of domesticated resources. In addition, domesticates represent only a minor dietary component against the many wild counterparts (Andersen 1991, 1993; Hartz et al 2007; Skaarup 1973). By the middle Neolithic (MN) however, it is clear that there is a commitment to agriculture, and domestic plants and animals predominate (Price et al 1995; Price and Noe-Nygaard 2009). The process seems gradual, involving a period of mixed domestic and wild subsistence activities.

This dissertation defines and builds a model of inter-site EBK faunal assemblage variability on a local, regional, and culture-wide scale. By analyzing published data as well as the fauna from three EBK sites and one transitional EBK-TRB site, all of which are likely to be different economically, I define the observed range of breadth and intensity of resource exploitation within the EBK and early TRB. I analyze the fauna from three EBK sites in northwest Zealand, Asnæs Havnemark, Fårevejle, and Trustrup, which, in conjunction with published data from Smakkerup Huse and the Store Åmose, allows a reasonably complete view of Mesolithic resource use in the northwestern parts of the island of Zealand. The material I analyze from Havnø provides some of the first robust comparative data across the Neolithic transition regarding resource exploitation. After building this model I address the hypothesis that if there is greater variability among late EBK faunal assemblages than between single EBK and TRB levels in transitional assemblages then terrestrial resource stress or changes in availability or use of terrestrial resources could not have been causes of the initial transition to agriculture. This in turn will help clarify the reasons for the transition of hunter-gatherer populations to agriculture in Southern Scandinavia by providing a new perspective on food crisis, or environmental change models of agricultural origins (Fischer 2002).

The research relies on three approaches: 1) traditional zooarchaeological analysis, 2) the analysis of carbon and nitrogen isotopic ratios in the bones of domestic dogs (*Canis familiaris*, sometimes *C.lupus familiaris*), wild terrestrial mammals, and Neolithic domesticates, and 3) analysis of all available and appropriate published EBK and ENI TRB assemblages, in addition to the four to be described here. This study expands the number of documented late EBK faunal assemblages in Northwest Zealand, and describes the fauna from one of the famous Danish transitional shell middens "køkkenmøddinger" (Andersen 1991, 1993; Bratlund 1993; Skaarup 1973). Particularly important is the analysis of Havnø, Jutland, possibly the largest early TRB faunal assemblage (Andersen 2008).

This approach will consider the late EBK as setting the stage for the introduction of domesticates in the region. Understanding the variability of faunal usage in the EBK and TRB offers the potential for understanding why aspects of the Neolithic were first accepted into hunter-gatherer economies. Sites under consideration here were selected for the differences they are likely to show in terms of faunal economy, for their explanatory potential in terms of local variability of both faunal exploitation and environment, for their proximity to one-another, for their availability for study and for their chronological comparability. Data collected also will complement a number of published EBK faunal collections from the Store Åmose, giving a picture of faunal exploitation stretching nearly 25 km from the Storebælt inland.

In sum, analyses contained herein evaluate the applicability of generalized models of EBK and TRB resource exploitation to different geographic areas of the culture, build a model of EBK regional variability specific to the island of Zealand, contextualize these data in light of all published materials, and evaluate the degree of shift between the last hunter-gatherer-fisher culture of south Scandinavia and the earliest farmers in the region.

Questions, Answers, and Goals

The big questions addressed in the course of this research included; 1) What can the faunal remains and C-N isotopic ratios tell us about human behavior and the local environment? 2)How variable are EBK faunal assemblages and what does this variability mean? 3) How well do the new and aggregate data fit accepted views of EBK resource use? 4)How much of a change in resource exploitation is apparent about the EBK-ENI TRB transition, particularly at Havnø, and what explanatory implications does this have for the origins of agriculture in the region?

EBK and ENI TRB zooarchaeological studies to date have been predominantly concerned in complementing excavation in order to discern the economy at individual sites. This study will be no exception. These analyses will provide, in conjunction with the data from Smakkerup Huse, the most Ertebølle sites with intensively reported fauna within a restricted area, helping to define the local economy of Ertebølle hunter-gatherers in northwest Zealand. In conjunction with the number of published sites in the Store Åmose to the east, this study will clarify the EBK economy of northwest and central Zealand, presenting data from the Storebælt to the Store Åmose, spanning several environmental zones.

Zooarchaeological methodology applied here will yield data about species presence, season of occupation, metric data, prey processing, and relative abundance. This will be used to interpret the economic activities at the sites as well as yield data about seasonal movements of EBK groups. Isotopic data will provide information about herbivore and human diets, may provide information about forest density, and will provide information about the movements of people exploiting the sites. These data will define the local variability of herbivore and human diets, adding a new dimension to comparative studies in the region, as well as providing a comparative baseline for discussing variability.

EBK sites are described as existing within discrete territorial zones, with an evenly spaced base camp and complimentary resource procurement sites (Andersen 1995). However, variability in resource exploitation among both types of sites is unclear. Three of the sites under consideration here are located within a restricted area of northwest Zealand, which with the Smakkerup Huse data will provide a base sample of the economic foci of sites within a local area. This should clarify the local environment and human activities therein and also provide a comparative reference frame within the context of the EBK.
Asnæs Havnemark, apparently a nearly unique situation, located on a long, coastal peninsula is particularly important. Fårevejle is important because it will be one of the only midden assemblages reported from Zealand. Trustrup is significant because as an inland site located in-between the Store Åmose and the Storebælt, it presents an opportunity to connect these regions. Havnø is significant due to its location, the fact that it spans the EBK-TRB transition, the large size of the TRB faunal assemblage, and the presence of domestic cattle (*Bos taurus*) and goats (*Capra hircus*), including juvenile and newborn individuals. To date, faunal assemblages from the TRB levels of the kitchen middens have not been large enough to accurately compare the two occupations.

Analysis of these four sites will document how variable faunal assemblages can be on a local level. Variability will be quantified through the application of various zooarchaeological data, including data from previously published faunal assemblages and the zooarchaeological analyses herein. It is important before considering any widespread patterns, first to have a local perspective, because it may give an indication of how much variability may be expected locally. The quantification of differences in faunal exploitation will be used to build a model of variability both on a regional and on a culture-wide level. It also will show patterns between similar resource zones, location, or other factors. Discussions of trajectories towards agriculture must rest on defined phenomena, and change cannot be evaluated without variability being quantified.

I expect that all sites will have different economic foci in terms of breadth of resource exploitation, assemblage specialization, seasonality, and intensity of exploitation. Any evidence of overhunting, albeit anecdotal, was noted. This is because high hunting pressure will result in a population containing more young individuals than are expected in a sustainably hunted natural population (Koike and Ohtaishi 1985, Munro 2004). Such a pattern may indicate stressed populations.

The model of variability is then used to evaluate the applicability of accepted models of EBK resource use and seasonal exploitation developed elsewhere to northwest Zealand (Price and Gebauer 2005; Rowley-Conwy 1983). It is clear that there is a degree of inherent cultural variability within the Ertebølle culture (Petersen 1984). This is as would be expected concerning a phenomenon that has considerable geographic reach coupled with high geographic and natural biological variability and the presence of a number of natural barriers (Aaris-Sørensen 1980).

The ultimate goal of this project was to help explain the transition to agriculture in southern Scandinavia by building a model against which EBK and TRB faunal data can be arrayed. This goal was to be addressed using data attained in this analysis and through a wide survey of all published EBK and ENI TRB faunal material, focusing on the largest assemblages, which are more likely to be representative. I define and quantify the faunal resource use preceding and during the transition, prior to MN. I evaluate inter -site EBK economic variation, and whether or not early Neolithic assemblages at sites with EBK occupations fall within this variation. Ultimately, I evaluate whether or not the differences between the

EBK and EN levels at Havnø, as well as between other transitional assemblages, fall within the defined regional and culture-wide variation among the EBK, as well as whether or not shifts in terrestrial resource availability or exploitation could have been causal in the initial shift to the Neolithic.

Changes in terrestrial resource use are indisputably an effect of agriculture, but whether there were changes in the availability of these resources which in turn resulted in agricultural origins is an open question. Variability is defined to include various classes of zooarchaeological and stable isotopic data (specifically relative abundance values, body-size data, butchery practices, and stable isotopic ratios). Examples of measures of variability as demonstrated are ranges of normalized relative abundance of fur-bearing species, range of Carbon and Nitrogen Isotopic ratios within species, and the proportion and patterning of marrow fractured specimens. If the Neolithic sample falls outside of the variation or range of the EBK sample, then there is an overall shift in procurement, use or availability of terrestrial resources.

Supposedly, weak evidence of food crises (Fischer 2002) would include highly variable EBK faunal assemblages and continuity with the early Neolithic. Stronger evidence would include highly variable EBK assemblages with Neolithic assemblages falling outside the variation. Still stronger would be EBK assemblages with low variability with a shift outside documented variability in the ENI TRB materials. The strongest evidence in support of food crisis models of agricultural origins would be low variability in regional EBK faunal exploitation and strong evidence of resource stress along with a shift outside the variability in the ENI TRB materials. These scenarios have powerful evaluative potential for food crisis models of agricultural origins in the region (Fischer 2002).

The goal of testing these hypotheses was to evaluate accepted views of trajectories towards agriculture by introducing new data and analyses into the debate while building a useable model of variability against which to compare future faunal analyses. I expect that questions regarding the degree of economic shift from the EBK to the ENI TRB are addressable using data produced in this dissertation, and permit more accurate explanations of the transition.

Results

Major findings of this project include the following: 1)Ertebølle faunal economies are less variable in northwest Zealand than they are elsewhere in the Ertebølle culture area and differences in site types are very subtle in terms of the faunal economies. This is contrary to what was expected in one of the more environmentally heterogeneous EBK regions (Paludan-Müller 1978). 2) Environments from which red deer (*Cervus elaphus*), roe deer (*Capreolus capreolus*), and wild boar (*Sus scrofa*) terrestrial species (hereafter together termed the big three) came are locally similar. This shows that most of this prey in northwest Zealand came from the same types of environment, indicating that ease of capture, not variable quality of populations dictated where hunting was taking place. 3) Specialized or seasonal satellite sites on Zealand take a different character than those elsewhere in the Ertebølle culture area. In other words, satellite camps for hunting prey other than the big three in particular have not yet been identified on the island whereas they are common elsewhere in the EBK culture-area. 4) The earliest Neolithic coastal populations at Havnø appear to have had a more domesticate-based animal economy than at other transitional middens, indicating a more marked shift at coastal sites usually considered to be indicative of continuity with the Mesolithic. Therefore, Neolithic occupation at shell-middens is not exclusively restricted to the continuation of largely Mesolithic practices, and included significant agricultural activities. This may indicate cultural continuity and a degree indigenous adoption of agricultural practice given the continuity of place. 5) Ertebølle resource use as a whole was wildly variable at multiple, nested scales, but much more homogenous on a regional level, possibly indicating consistent difference between regions, differences that are also reflected in other types of material culture. 6) Deer populations on Zealand show marked variability in terms of animal-size between inland and coastal hunting locations, and little difference is seen in populations between northwest Zealand and elsewhere in the EBK area. This indicates that contrary to previous studies, size difference among these species is not due to the isolation of populations on the island of Zealand, but may be related to other processes. 7) Little or no selective body-part transport is observed on Zealand, in contrast to some areas of the EBK. This again indicates differences between cultural practice between the EBK of Zealand and elsewhere. 8) Given the model of variability, the shift in the earliest Neolithic may not have been restricted to the simple addition of domesticates; it also may have included shifts among the use of wild resources. 9) Evaluating the transition requires regional perspective, as broad variability in resource use and breadth culture-wide indicates the ability to weather even major changes in the environment and the availability of food, while on the regional level, this ability may have been reduced.

Unfortunately, perhaps the main hypothesis which proposed to assess the degree of shift in use of wild resources at Havnø versus variability in EBK resource use, was not fully addressable given the dataset produced. This is predominantly due to the current lack of clear chronological separation between the Mesolithic and Neolithic materials at the midden. Shell middens are exceedingly complex in their stratigraphy, mostly due to their very complex depositional processes, nature of their formation, and taphonomy. At present, this complexity is unresolved. Therefore, the Havnø midden assemblage must be treated as a unit comprised of both EBK and TRB materials which in most cases has not been separated.

Conclusions

From the above findings, this dissertation reports several broad conclusions to be made about Ertebølle resource use and the transition to agriculture in South Scandinavia. First, environmental change, even if evident, could not have compelled Ertebølle groups to adopt agriculture because of significant flexibility of Ertebølle groups in their ability to switch among all available resources and therefore weather all but a complete environmental catastrophe. Second, evidence presented here does not indicate a gradual agricultural adoption but, in fact, a more abrupt transition, with animal husbandry in strong evidence even at a transitional shell midden. This also argues against purely immigration-based models of agricultural origins, due to the continuity of site location. I argue for strong and nested regionality in faunal resource use in part independent of environmental variability, particularly in the EBK, and for the possibility of such regionality in the earliest Neolithic as well. Data are discussed in the following pages.

Chapter 2: Archaeological Background

Introduction

The literature concerning the transition to agriculture in southern Scandinavia is considerable, and encompasses the period of time where human beings shifted from foraging ways of life to farming. This time period from approximately 5400 to 3500 cal B.C. corresponds to the Ertebølle culture (EBK), the last foragers of south Scandinavia and the subsequent earliest phase of the Neolithic Funnel Beaker Culture (EN TRB). In this two thousand year period, south Scandinavia moves from a landscape recently modified to a permutation of its present form and inhabited by hunter-gatherers using wild animals and plants obtained skillfully from the natural environment to a completely different world inhabited by sedentary farmers, entirely reliant on domesticated plants and animals and marked by emerging social inequality. This chapter will explain the history of human beings in the region from the start of continuous occupation, through to the Neolithic. Another major actor, the landscape, and its changing nature is discussed. A theoretical discussion of agricultural origins follows. Next, a number of representative faunal assemblages about the transition will then be discussed. Finally the archaeological background of the four sites analyzed in this dissertation is presented. The goal of this chapter is to give the reader the appropriate background prior to the in-depth discussion of the particular case studies presented by this dissertation.

The Landscape

One of the most characteristic traits of the northern European landmass from approximately 5400 to 3300 cal B.C. was the constant change in the coastal landscape of Denmark. The coastline was not stable throughout this period due to melting ice, fluctuations in global climate, and the rebound of the land itself after the weight of the ice was removed by melting at the end of the last glacial maximum (Christensen et al. 1997). Beginning with the start of the recession of the glacial ice sheets around 20,000 years ago, sea level began to rise, and by 5400 B.C., around the middle of the Atlantic period, had stopped rising as rapidly as it had during the Boreal and Early Atlantic Periods (ca. 8500-6000 B.C.)

(Christensen et al. 1997; Christensen 1995). This rise completely changed the entire northern European landscape, in that what was formerly a large continental landmass connecting what is today the United Kingdom with Europe and Scandinavia at the outset of the Holocene had become the North Sea by the middle of the Atlantic period (Coles 1998). While not uniformly and quickly-rising anymore, over the course of much of the EBK and into the early TRB, the Littorina transgressions, a series of sea-level fluctuations of a single to several meter rises and falls in sea level occurred (Christensen 1995).

By around 6000 B.C., the effect of the melting ice on sea-level had slowed, and then had largely ceased after over a millennia of being a major factor driving the rise of the sea (Christensen et al. 1997). The other major cause of sea-level fluctuations was the land itself (Christensen 1995; Christensen et al. 1997). On the rebound after the melting of glacial ice, Denmark has been tilting along an axis running from the northwest to the southeast, pivoting along a line running approximately through the middle of Jutland, the middle of Fynen, and through Falster (Figure 2.1; Mertz 1924).

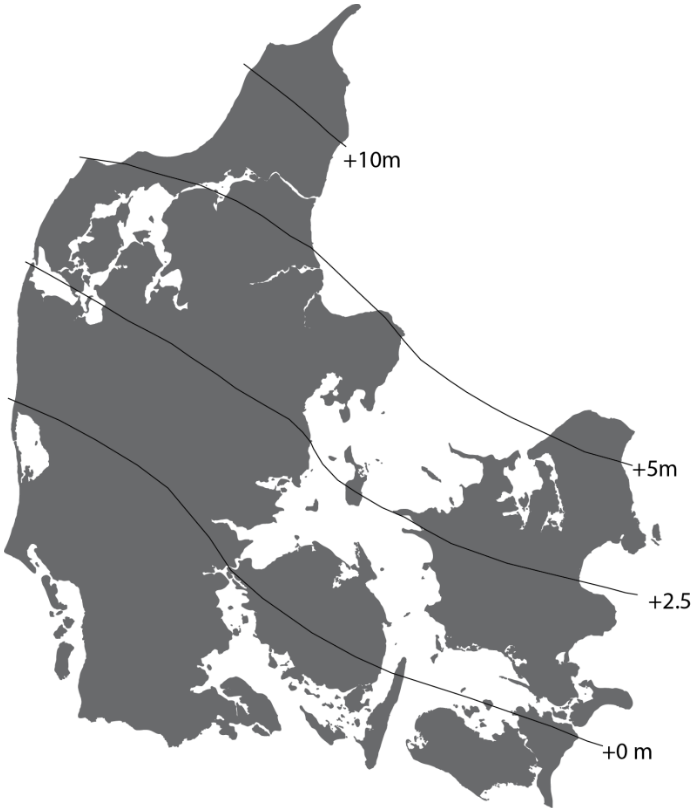


Figure 2.1: The glacial rebound of Denmark (after Mertz 1924)

One result of this rebound is that not many EBK sites (and indeed other stone age sites) are known from southwest of the “0” isobar depicted in Figure 2.1, and those that have been investigated have been largely underwater (e.g. Møllegabet II, Tybrind Vig, Ronæs Skov, and the Kongemose settlement on the Argus Bank) (Grøn and Skaarup 1991; Skaarup and Grøn 2002; Andersen 2009; Fischer et al. 2007a). Thus, it cannot in any way be assumed that the current geographical position of a Mesolithic site today reflects its relationship with the coast during the Atlantic Period, and that to understand the local environmental and geographic conditions during this time in the past, a consideration of and recognizance about these factors is a must.

The Earliest People in South Scandinavia

From the late Paleolithic, southern Scandinavia has been more or less continuously inhabited by human beings. This is not to say that these are the earliest inhabitants of the region, as man is present during interglacial periods (Møhl-Hansen 1954). However, this late Paleolithic period (ca. 12,000-ca. 9000 B.C.) was a time of profound change in the landscape of the region, with the northern European ice caps receding, and the landscape constantly changing and becoming more inhabitable (Petersen 1993; Fischer 1993). After millennia of coverage, the massive glacial ice caps were completely gone by around 16,000 B.P., and there is incontrovertible evidence of human presence by 14,100 B.P. (Mortensen et al. 2008; Aaris-Sørensen 2009).

With the ice sheets gone or receding, human beings moved in, and all of the four northern European Paleolithic cultures, (in order from earliest to youngest) the Hamburg, Federmesser, Bromme, and Ahrensburg are currently established, although poorly represented, in Denmark (Fischer 1993; Holm and Rieck 1992; Aaris-Sørensen 2009). Finds are scant and generally consist of little more than flint (Holm and Rieck 1992). As a result, not much is known about these early inhabitants. However, it is surmised that they were large-game hunters, and evidence from Slotseng, Jutland, confirms the hunting of reindeer by Hamburgian peoples in a more heterogeneous environment than previously supposed (Holm and Rieck 1992; Mortensen et al. 2008).

Later during the Holocene, and therefore the Mesolithic, three distinct cultures are evident, in sequence, prior to agricultural origins in the region: The Maglemose, Kongemose, and Ertebølle Cultures. The oldest evidence of Mesolithic peoples from Denmark comes in the form of hunted and butchered elk (*Alces alces*), dating roughly to the transition from the Pleistocene to the Holocene, which is chronologically ca. 7500 and 6000 B.C., or the Maglemose Culture (Grøn 1987; Hansen et al. 2004). Owing in part to the profoundly unfamiliar geographic makeup in northern Europe at the time, with continental Europe connected to what is today the United Kingdom via Doggerland, the Maglemose culture generally extended across the entire region, from England to the Baltic, occupying large areas which are now submerged (Andersen 2001; Coles 1998). Maglemose hunters are believed to have been inland hunters, focusing on terrestrial game (Petersen 1993).

As the sea rose (Coles 1998), the intermediate Mesolithic culture in the region, the Kongemose, occupied what is today Denmark, Skåne, and northern Germany (Sørensen 1996). Typically defined by its large and characteristic flake technologies, the Kongemose also was distinguished by portable art, recognizable by linear incised lines and images on portable objects (Sørensen 1996). The Kongemose economy was based on multiple resources from land and sea. Seasonal availability of resources dictated that groups of Kongemose individuals could not get everything they needed from a single site or locality and therefore had to move about their landscape (Fischer et al. 2007a; Sørensen 1996). Data on the specific importance of food resources are not abundant, but as evidence from the submerged Kongemose site on the Argus Bank in southern Denmark demonstrates, the most important foods may have been marine fish, followed by terrestrial game, nuts, and fruit (Fischer et al. 2007a). Actually, the subsistence economy may have not been dissimilar to the preceding and subsequent Maglemose and Ertebølle cultures (Sørensen 1996).

The Ertebølle Culture (EBK)

The Ertebølle (hereafter EBK) is the last phase of the south Scandinavian Mesolithic, spanning the period from 5400-3950 cal B.C. (Figure 2.2). The EBK encompassed all of what is today Denmark, southern Sweden, northern Germany, and northern Poland and is commonly divided into three phases, falling within the Atlantic Period of northern Europe (6000-4000 cal BC) (Andersen 2007; Czerniak and Kabaciński 1997). The people of the EBK are best referred to as predominantly "coastal fishers", utilizing hunted and gathered terrestrial and marine flora and fauna, some perhaps under varying degrees of management (Andersen 2007; Zvelebil 1995). Widespread plant use for both subsistence and non-food uses is documented (Kubiak-Martens 1999; Price and Gebauer 2005). EBK social complexity generally is considered to be "complex hunter-gathers" if viewed in evolutionary frameworks, and increased over its course on a trajectory towards the appearance of aspects of the Neolithic around 3950 cal B.C. (Fischer 2002; Petersen and Meiklejohn 2007; Price 1985; Richter and Noe-Nygaard 2003; Rowley-Conwy 1999). EBK technology was highly developed and included boats, specialized hunting and fishing equipment, and characteristic ceramics in the middle and late EBK (Price and Gebauer 2005; Price and Noe-Nygaard 2009). EBK groups were likely in contact with Neolithic populations to the south, as evidenced by unambiguously Neolithic objects, such as shoe-last adzes, which are found in a number of EBK contexts (Fischer 1982; Price and Gebauer 2005).

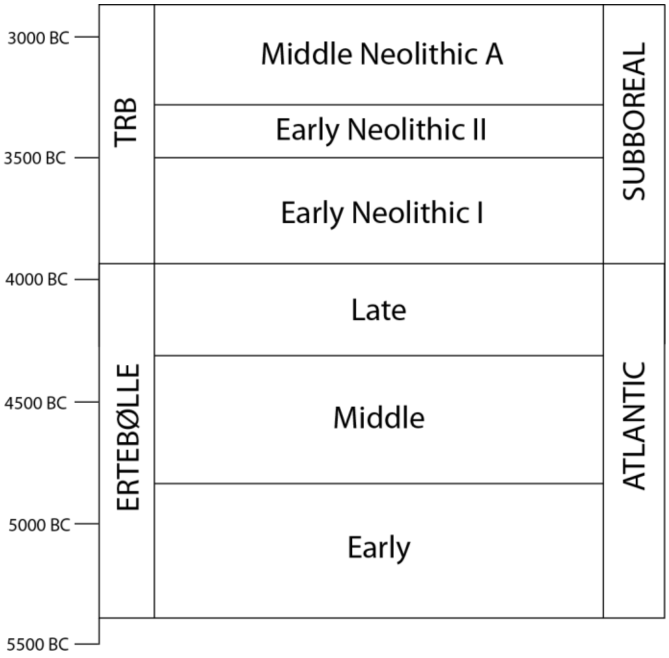


Figure 2.2: Chronology of the transition to agriculture in southern Scandinavia

Among the EBK, there are inland and coastal sites, representing either one population moving seasonally or separate populations (Johansen 2006). Investigated inland sites are few in number, and isotopic studies of individuals and their dogs show a significantly marine diet in most cases, indicating a proportion of their lives spent at the coast (Fischer et al 2007b; Noe-Nygaard 1988). With notable exceptions such as Ringkloster and the atypical inland situation in the Store Åmose, Zealand, studies of size variation, location, importance, and economy of EBK sites have focused largely on coastal and underwater contexts (Andersen 1986, 1994-1995, 1995, 2009; Gotfredsen 1998; Grøn and Skaarup 2004; Johansson 1999; Larsson 1997; Noe-Nygaard 1995). Studies have revealed differences in the importance and size of sites, usually with evenly spaced "base camps" (e.g. Bjørnsholm, Ertebølle, Krabbesholm, and Smakkerup Huse) and less intensively occupied and more seasonally utilized resource procurement and special purpose sites (e.g. Aggersund, Hjerk Nor, Rønbjerg Strandvolde, and Agernæs)(Andersen 1978, 1991, 1995, 2004, 2005; Andersen and Johansen 1986; Hatting et al 1973; Johansson 1999; Price and Gebauer 2005; Richter and Noe-Nygaard 2003; Skousen 1997-1998). Over the course of the EBK, the number of settlements in coastal areas increases markedly, and sites are said to show an increasing degree of economic specialization (Andersen 1995, 2009; Richter and Noe-Nygaard 2003). The correlation between the number of sites and their increasing specialization has been related to the eventual presence of domesticates (Richter and Noe-Nygaard 2003). Further, the presence of clustered burials indicates a degree of settlement system stability, also evidenced by long-term accumulations of materials at coastal midden sites and general site location fidelity (Albrechtsen and Petersen 1976; Andersen 2007; Fischer 1997; Grøn and Skaarup 2004; Larsson 1986).

The Funnel Beaker Culture (TRB)

The early Neolithic Funnel Beaker Culture (Trichterbecherkultur, TRB) in southern Scandinavia is divided into two periods, the early Neolithic I (ENI, 3950-3500 cal B.C.) and the early Neolithic II (ENII, 3500-3300 cal B.C.) (Figure 2.2). The EN is then followed by the middle Neolithic (MN) and subsequent periods (Koch 1998; Price and Noe-Nygaard 2009). The early TRB (ENI) archaeological record is significantly less well represented than the EBK sample in southern Scandinavia, and faunal samples usually are very small (Andersen 2007; Johansen 2006; Koch 1998). Catching sites and settlement sites coincide. The former contains mostly wild resources and the latter reliant on domestic crops and animals (Johansen 2006). At the start of the ENI there are clear indications of cultural differences from the EBK, including new ritual practices and material culture (Koch 1998). However, there are intermediate EBK-TRB ceramic forms (TRB Type O) as well as continuity in other forms of material culture such as lithic categories, stone tool assemblages, some aspects of burial customs, and site location in certain cases (Koch 1998; Price et al 1995). There is not much evidence for the overwhelming contribution of agricultural activity to the economy in the ENI, and this situation continues until the subsequent ENII, when agricultural activities and settlement become more visible (Jensen 1996; Price et al 1995; Price and Noe-Nygaard 2009). Further, widespread forest clearance is not evident until the Middle Neolithic (Andersen 1992). Previously reported settlement site faunal assemblages are rare or extremely small but nearly always indicate the overwhelming dominance of domesticates (Koch 1998; Møhl 1975; Nielsen 1985; Nielsen 1997). As for ENI catching sites, almost all data come from coastal "køkkenmøddinger", or shell middens with EBK and early TRB occupations. This is the case at Bjørnsholm, Norsminde, Visborg, and Sølager, although there is an inland catching site at Muldbjerg I and a transitional non-midden site at Wangels, in northern Germany (Andersen 1991, 1993, 1998; Bratlund 1993; Hartz et al 2002; Noe-Nygaard 1995; Skaarup 1973). All of these sites have a predominance of wild game.

Agricultural Origins

The adoption of domesticated animals and plants in Scandinavia was one of the last transitions to agriculture in Europe and has attracted profound and long-lasting scholarly interest (Fischer 2002). There is clear evidence for at least the presence of animal husbandry, cereal cultivation and TRB ceramics by around 3950 B.C. (Fischer 2002). There are multiple idiosyncrasies about the transition in the region, however. These include the rapid introduction of domesticated animals and plants but their low importance subsequently for nearly half a millennium, culture change in the form of new types of ceramic and settlement system but also evidence of cultural continuity, and large-scale environmental changes concurrent with all of the above (see Fischer and Kristiansen 2002). As a secondary adoption, not all models of agricultural transitions are applicable to this specific case. Consequently, there has been the development of considerable scholarship specific to the region.

There are three general explanatory points of view regarding the impetus for agricultural origins in southern Scandinavia (Fischer 2002): migration, food crises precipitated by various causes, and socio-economic changes. Each of these explanatory frameworks, in the light of dominant archaeological paradigms and new evidence and types of evidence, periodically has come to the forefront of the debate (Fischer 2002; Klassen 1999; Larsson 2007; Madsen 1986; Petersson 1999; Price 2000; Schulting 2010; Skoglund et al. 2012; Sørensen and Karg 2012). Oftentimes, one explanation will languish until resurrected with new methods. This is the case with new genetic data pointing to discontinuity between the earliest farmers in the region and contemporary (albeit not EBK) hunter-gatherers (Skoglund et al. 2012). Similarly, many varied processes have been described as causing the transition (Grøn 1997; Petersson and Meiklejohn 2007; Rowley-Conwy 1984, 1999). Another aspect of the debate is the speed of the transition, which is considered to be either rapid or gradual (Madsen 1986; Rowley-Conwy 1999), or a more complex situation (Price 2000; Price and Noe-Nygaard 2009). Finally, the transition has two main axes: economic change and cultural change, not always happening in tandem (Larsson 2007). Depending on one’s theoretical tendencies, these two factors are either considered together or separately with profound effects on the conclusions (Rowley-Conwy 2004). The resulting picture is complex, requiring flexible models which can account for processes involving differing aspects of human culture and its environment, occurring at different times and at different speeds.

The past model which has been thought to fit the transition best is that of Zvelebil (1986) and Zvelebil and Rowley-Conwy (1984). Their three part model considers an availability phase (in which hunter-gatherer populations are aware of agriculture but do not adopt it), a substitution phase (with a mixture of farming and wild resource exploitation), and a consolidation phase (which involves a true commitment to agriculture). While not explanatory (Price 2000), the reality of the EBK and TRB data seem to fit best in this model (Hartz et al 2007). This model is particularly appropriate for this study as I propose a Mesolithic focused approach: attempting to explain the transition based on processes occurring in the Mesolithic. Thus, I focus on the *availability* phase (corresponding to the EBK data) and the *substitution* phase (corresponding to the ENI TRB data) of the model.

Previous Research

Researchers productively have used zooarchaeological analyses in EBK research for over a century (Degerbøl 1942; Enghoff 2009; 2011; Hatting et al 1973; Hede 2005; Madsen et al 1900; Noe-Nygaard 1974; Rowley-Conwy 1994-1995). Research utilizing the stable isotopic ratios of carbon and nitrogen similarly has been applied due to the relationship of EBK hunters with the sea (for example Fischer et al 2007b; Noe-Nygaard 1988; Price et al 2007; Richards et al 2003; Tauber 1981). However, only recently have the analyses of carbon and nitrogen isotopic ratios started appearing regularly in zooarchaeological analyses, yielding information not only about human diet, but also the environments from which animals were taken (Craig et al. 2006; Gotfredsen 1998; Hede 2005; Noe-Nygaard 1995; Richter and Noe-Nygaard 2003). Published isotopic data are limited to illustrating change over time or local environmental conditions and have not been applied to documenting the potential environmental variability across the EBK, an important baseline consideration if studying economic variability (Craig et al 2006; Fischer et al 2007b; Hede 2005; Noe-Nygaard 1995; Noe-Nygaard et al 2005).

Well-reported EBK faunal assemblages are either widely scattered geographically (Bratlund 1993; Hede 2005; Hodgetts and Rowley-Conwy 2004; Jonsson 1988; Noe-Nygaard 1995; Richter and Noe-Nygaard 2003), or when involved in regional studies, atypical in location and minimally documented (Andersen 1995; Johansson 1999). Such studies usually are focused on well-preserved collections, those from particularly important sites, or for the illustration of specific phenomena, such as the procurement of particular resources (Enghoff 2009; Hodgetts and Rowley-Conwy 2004; Richter 2005; Richter and Noe-

Nygaard 2003; Trolle-Lassen 1992). However, the quality and quantity of research across the culture-area varies wildly.

Faunal analyses accompanying EBK excavation publications generally can be divided into three classes: simple lists of fauna (Andersen 1975; 1991; Madsen et al. 1900), higher quality descriptions of faunal remains (Degerbøl 1942; Møhl 1978), and modern environmental and economic analyses. Such modern studies often include isotopic analyses and considerations of fine-grained seasonal data, age assessments, and butchery assessments (Enghoff 2009; 2011; Gotfredsen 1998; Hede 2005; Richter and Noe-Nygaard 2003). Further, such modern analyses, when taken in conjunction with isotopic analyses, have substantial potential for adding important quantifiable data about habitats of individual species (Noe-Nygaard 1995).

Previous Regional Studies

Several regional archaeological analyses of EBK settlement in Denmark have been completed (Andersen 1995; Fischer 1997; Gebauer and Price 1990; Johansson 1999). These studies focused predominately on variation in size, type, and location of settlements in comparative terms, with some discussion of the animal-based economy of the region. Søren Andersen (1995) focused on the Limfjord Region, northern Jutland, an area which for likely geographical reasons did not have inland settlement and did not include a significant terrestrial zooarchaeological component in the analysis. Axel Johansson (1999) investigated site size and location with, for the most part, only simple counts of the presence or absence of species at certain locations within his study region in southwest Zealand. A. Birgitte Gebauer and T. Douglas Price focused on the Mesolithic and Neolithic settlement of the Saltbæk Vig area of northwest Zealand, resulting in the excavation and publication of the fauna from Smakkerup Huse (Gebauer and Price 1990; Price and Gebauer 2005). Anders Fischer (1997) addressed site location change within the context of the littorina transgressions. The only region in Denmark intensively investigated zooarchaeologically is the Store Åmose, about which a number of EBK faunal analyses have been published or analyzed (Gotfredsen 1998; 2003; 2004a; Noe-Nygaard 1995). However, this region, an inland lake system, is atypical for the EBK.

A Special Note Concerning, *Regionality and Biotope Exploitation in Danish Ertebølle and Adjoining Periods* by Inge Enghoff (2011)

Recently, a multiregional study of eleven Stone Age zooarchaeological assemblages including a number of Ertebølle localities was undertaken and published as a large volume (Enghoff 2011). The aims of the volume were to, "deliver a regional analysis, based on detailed study of new, high-quality bone assemblages (fish, birds, mammals), compared to archaeological interpretations of the sites and re-evaluation of earlier publications" (Enghoff 2011:7). Further, the goal was to investigate temporal change on a regional level in various areas through the Mesolithic into the Neolithic and provide a base analysis of material to which subsequent stable isotopic and DNA analyses could be applied. This major work requires more than cursory mention, as it represents a large dataset, a regional approach, and differs from this dissertation in several key regards.

In the book (Enghoff 2011), four regions were investigated, including northern Jutland, Eastern Jutland, the Limfjord, and northern Zealand. The dating of the sites was variable, with more of the material belonging to the EBK than the other periods under investigation. For each site, basic quantification was reported for mammals, birds, and fish, including Number of Identified Specimens (NISP) values, and more in-depth analyses such as ontogenetic aging, establishment of season of occupation, sexing, and various other analyses dictated by the quality of the bone assemblages themselves. Further, all available published assemblages from the regions in question were also reviewed in order to offer a comparison with the new data presented. Last, general conclusions about classes of resources and the exploitative strategies required to procure them were made.

My approach differs from Enghoff's in three key ways. First, I did not analyze fishbone as these have already been addressed from the sites I worked with (Ritchie 2010; Robson et al. in prep). Second, there are some methodological differences between our analyses. Lastly, I take a different approach to interpretation and contextualizing Stone Age materials.

In general, I use very similar methods to those employed by Enghoff (2011), but with some key differences (Chapter 3). I have chosen to include more than one statistic of zooarchaeological quantification, using Minimum Number of Individuals (MNI) in addition to NISP values to understand the relative frequencies of species. I do this in an effort to both maximize comparability between my analyses, but also with other, previous analyses in a recognizance of variable degrees of preservation and fragmentation between sites and the effects of these factors on quantification. This is also why I measure almost each and every recovered bone from the sites I analyze in an effort to quantify potential inter-site differences. I find that it is paramount not only to describe the condition of the bone, but also to quantify these traits. Where appropriate, I apply more in-depth measures of body-part representation in order to elaborate possibly on the mechanisms by which the bones came to be found at each site. Finally, I review comparable assemblages from across Scandinavia, as my focus was not only to identify inter-regional differences, but also intra-regional differences.

It is my suspicion that these major methodological differences stem in part from the divergent academic training underscoring our approaches to archaeological material. Correspondingly, our conclusions and approach to understanding what the data mean vary as well. While we are both zooarchaeologists, I was trained in both biology and anthropology, and therefore focus on understanding the human behaviors underlying what is observed in the archaeological record through the lens of animal bone. Enghoff's (2011) overlying approach was different, in which human groups are portrayed almost as passive actors. That is, what is found at an individual site is taken to indicate directly what was available locally, and materials are presented with limited consideration of the role of these resources in broader context and with limited regard for the archaeological contexts of their recovery. Further, changes in exploitation were most often assigned simply to changes in the environment. In contrast, I attempt to fit my results into models of hunter-gatherer resource exploitation, and attempt to identify local and widespread variability independent of resource availability. This is not to say that either approach is better, but simply divergent.

This contrast between our works is most clearly seen in the conclusions and syntheses concerning our datasets. Enghoff's conclusions are very restricted, and generally limited to considerations of what species were probably abundant at sites, what was hunted and when, what was more or less important, and what the local environment probably looked like. My considerations of the data (Chapters 9, 10, 11) include these types of assessments, but also further consideration of the data in the frameworks of hunter-gatherer models of subsistence (Binford 1980), and culture-wide in terms of agricultural origins. In other words, I not only describe my materials, but also attempt to interpret meaning, within reason, in terms of human behavior. Nonetheless, my hope is that the two datasets can be compared, as the ultimate goal is to understand the choices, lives, and world of Stone Age groups in Scandinavia through their use of animal resources.

Review of Previously Reported Faunal Assemblages

Any comparative study that integrates new and old data must endeavor to sort through past research in a way both including everything, but selectively deciding which of those previous data that are more useful than others. All data are not of equal utility. There is no correct way of doing so, but in an effort to conclude with a best-fit and most-likely story as to actual events, all sources of variability in past reporting will be acknowledged and dealt with according to common practice and common sense.

As mentioned earlier in this chapter, certain publications are rife with problems, and ambiguous determinations are just one of these issues. Ultimately, upon review of the considerable literature, great variation in two aspects of reported faunal assemblages from Ertebølle and TRB sites is evident: quality of the reporting and analysis, and the traits of the assemblages themselves. I will deal with these problems in turn.

The quality of the scholarly reporting and analysis of sites and faunal assemblages is often at the whim of a number of factors, many often unrelated to archaeology at all. For example, these include changes in historical approaches to science, inter-observer variation, variable archaeological methodologies, new technologies, and divisions among the academy. All of these factors and more make it difficult to sort meaningfully through the published literature in a meaningful way. It is a difficult task, but not impossible. Historically in Scandinavia, early archaeological investigations have enjoyed a degree of rigor much higher than elsewhere in the world. Some of this stems from the middle of the 19th Century, when archaeology as a discipline, still in its infancy, produced the two pioneering Danish scholars Jens Worsaae and C. Thompsen, who rejected conclusions made without evidence to back them up, and demarcated the three-age system respectively (Kristiansen 2002). Indeed, perhaps the earliest interdisciplinary archaeological investigations in the world were the explorations of the Danish shell middens, the "Køkkenmøddinger," by a team comprised of an archaeologist, a zoologist, and a geologist, later termed the "First Kitchen Midden Commission". Publishing several reports between 1848 and 1860, the team set the stage for subsequent interdisciplinary research continuing to the present (Kristiansen 2002).

The interdisciplinary approach largely has carried on today, partly due to the history of research of this type but also due to segregation of disciplines between distinct academic departments in Denmark. By necessity, much Stone Age research concerning aspects of the natural world (e.g. faunal remains, palynological samples, geological modeling and studies of sea-level changes) is carried-on by geologists and not archaeologists. In fact, most of the archaeozoologists in Denmark today and in the past who have published much of the relevant and important literature are trained geologists or zoologists and not archaeologists by training. This means that in order to analyze animal bone from Stone Age sites in Denmark, Danish archaeologists must go to specialists outside archaeology to do so, therefore continuing this tradition of interdisciplinary research. However, this also means that zooarchaeological questions are often asked as afterthoughts by archaeologists, and do not necessarily factor into primary research undertakings.

On the other hand, the fact that most such research has been done by experts in other fields has increased the quality of early investigations. Faunal reports by Herluf Winge, Magnus Degerbøl, and Ulrich Møhl before the 1950s and as far back as the 19th Century are oftentimes very useable. This advantage is crucial in the case of Havnø and Fårevejle, first investigated and published around the turn of the last century and included as major parts of this study (Madsen et al. 1900). In comparing published materials, inter-observer variation and variable archaeological methodologies are less rectifiable. Part of this variation and change in methodologies is due to the long history of research in the region. As times change, methods change. An example of this is the advent of screening, in particular water-screening in more recent decades. Whether or not an assemblage was screened or not significantly affects how well represented smaller-sized materials within an assemblage are, therefore influencing the relative abundance of species.

The reporting itself is often problematic, ultimately resulting from the methodological decisions made prior to, or during analysis by the archaeozoologist. This study is no exception, as I am required to decide how best to handle disparate data in a meaningful way. Of course, zooarchaeology has attempted to mitigate comparative problems by creating and standardizing comparative (such as MNI and NISP) but even these are affected by various factors, such as degree of overall fragmentation (Marshall and Pilgram 1993), confidence of identification or lack thereof, and whether or not particular statistics are reported.

Finally, the assemblages themselves also play a role in the difficulties comparing sites with one-another. While the bones are not actors, the sum total of all of the events resulting in the creation of the "assemblage" introduces much variability into comparative studies. Such factors include bone fragmentation, all taphonomic factors, geological change, and, importantly, the very species that make up the bones. These factors may affect the assemblage before any archaeologist or zooarchaeologist ever handles the material, and may also influence whether or not this ever happens.

Notwithstanding these issues, there are an exceptionally large number, published and unpublished both, of faunal assemblages from southern Scandinavia dating to the Ertebolle and early Neolithic. Therefore, in this text more than cursory mention will be made only about those assemblages about which interesting data have been published, the data are of good quality, or some trait is of particular note.

Notwithstanding this prose discussion, sites that are starred are discussed further in quantitative terms in the synthesis Chapters (9 and 10) based on criteria set out in those parts of this dissertation.

Previously Reported Ertebølle and Early Neolithic Sites on Zealand

In general, the topography of southern Scandinavia has been altered profoundly by sea-level rise, isostatic rebound, and other factors since the end of the Middle Stone Age (see above). This has, as one might expect, affected where research has been done on Stone Age subsistence. Generally, sites found southwest of a line running roughly south of Zealand, through Fynen, and through southern Jutland are in many cases underwater and only recently have been explored due to methodological difficulties. However, due to their underwater locations, some of these sites have yielded exceptionally well-preserved animal bone and other organic cultural materials (for example Andersen 1985, 2009; Glykou 2011). Due to these geological and geographic changes however, overall, there are markedly fewer sites southwest of that line in Denmark than there are to the northeast of it.

Zealand represents a distinct situation relative to the rest of the Ertebølle area in terms of faunal resource availability. It is now well accepted that aurochs (*Bos primigenius*), badger, bear (*Ursus arctos*), elk, lynx (*Lynx lynx*), and polecat (*Mustela putorius*) were all locally extinct on Zealand by the Ertebølle period, but continued to be extant elsewhere in southern Scandinavia into the Neolithic (Aaris-Sørensen 1980, 2009). These local extinctions are important for several reasons. First, presumably due to their absence, other species of the same resource type (e.g. fur animals for example) would have to be taken in greater numbers by humans. Second, when members of the genus *Bos* reappear at or around the transition to agriculture, at the start of the TRB, the specimens found are domestic cattle as no wild cattle are present locally by that time. This is of the utmost importance as it allows confident chronological identification of the arrival of the earliest domesticates on the island. Unfortunately, this situation is not mirrored elsewhere in southern Scandinavia, as difficulties differentiating wild and domestic *Bos* sp. often severely hamper the utility of transitional assemblages in that the degree to which domesticates are represented is masked (Chapter 7).

Over the years, a number of faunal assemblages from the island of Zealand have been published, and given methodological advances over the years, they vary in quality. Many of these published assemblages will be dealt with, in turn, here. The Åmose sites are the best represented in a regional sense, with a tight cluster of sites and completed analyses located around the inland lake system. In this rather restricted area, a clear picture of variation in inland resource use is visible. Elsewhere, most other analyses are found at the coasts, in western, northern, or eastern Zealand.

Bodal*

Bodal, a late Mesolithic but mostly Early Neolithic settlement site located in the Store Åmose, was excavated by Tom Brædstrup-Holm and Uffe Seneka Nielsen in 2004 and analyzed by Anne Birgitte Godfredsen that same year (Gotfredsen 2004a). As is typical for inland sites in the Åmose, the fauna at this site are dominated by the big three, comprising over 90% of the faunal material. However, a number of bird species, including rare pelicans are represented, as are some fish. Of the mammals, the majority is red deer. Other species are rarer, but include fur animals as well, whose number, while not approaching that at other sites, is relatively high for the Åmose, and may indicate more of a use of these species than elsewhere. Human ccupation of the site is placed in the summer and autumn based on multiple lines of evidence (Gotfredsen 2004a).

Karrebæk-Kybsø Fjord System Assemblages

Recovered from Axel Degn Johansson's settlement survey of the Karrebæk-Kybsø Fjord system in southwest Zealand, the faunal materials from a number of localities were published in an extremely preliminary fashion (Johansson 1999). In general, the published data are of little use other than to confirm that faunal use in this region of southwest Zealand conforms roughly to that in other areas of Zealand. Faunal remains were recovered from Lundebakke Syd, Even Øst, Fiskerhuset, Møllekrog Vest, Lønned Vest, Slutstenen I and II, Kalrsgab, Bønvig, Nørremarksgård II and III, Humlebakke Syd, Rønnen Syd II, Mellemste Sandhuk, and Lilerøn (Johansson 1999). All sites date to the EBK. All assemblages are dominated by the big three, usually predominated by red deer, and contain little else. At some sites, few specimens of fur animals and marine mammals appear as well.

Havnelev*

Located northeast of Præstø fjord, east-central Zealand, Havnelev was first excavated by Therkel Mathiassen in the first half of the 20th century, and faunal materials, while modest in number, were analyzed by Magnus Degerbøl and Ulrich Møhl (Koch 1998; Mathiassen 1940). Dated to the ENI, and interpreted as a farming settlement, the assemblage consists mostly of domestic cattle, sheep (*Ovis aries*) or goats, and domestic pig, with cattle being the best represented. Very modest numbers of wild animals are also present, including the big three as well as sea mammals and domestic dogs (Koch 1998). In many ways however, the assemblage is probably not representative, and while some numbers of specimens are reported, the numbers are inconsistently reported.

Klintesø

Klintesø was excavated by the Second Kitchen Midden Commission and published at the end of the 19th Century (Madsen et al. 1900). The site is a køkkenmødding, located east of Zealands Odde in northern Zealand. Faunal materials were analyzed by Herluf Winge, and, while numbers of specimens are reported in an irregular fashion, a general picture of the fauna can be ascertained. The bird remains are of raptors and seabirds, including the extinct great auk (*Pinguinus impennis*) (Madsen et al. 1900). There are several species of fur mammal, and the big three are represented. Several specimens of domestic animals are also present, presumably from the upper layers of the stratified midden, and include ovicaprids, and at least several specimens of horse (*Equus caballus*). Also found are sea mammals, including harbour seals (*Phoca vitulina*), grey seals (*Halichoerus grypus*), and the harbour porpoise (*Phocoena phocoena*). Unfortunately, no seasonality data are available (Madsen et al. 1900).

Lollikhuse*

Lollikhuse, excavated by Søren Sørensen, is a settlement site located on the western margin of Roskilde Fjord in north-central Zealand. Occupation ranges from the Kongemose to the Bronze Age, with the majority of the material coming from the late Mesolithic and early Neolithic. Materials fit the typical pattern for Ertebølle assemblages, consisting of nearly equal numbers of red deer and roe deer. There are fewer boar and a number of other species represented to a lesser degree. Domestic cattle are present in low numbers. The seasonality of the site was not described by Magnussen (2007), although she describes a previous, unpublished Master's thesis by Malene Friborg concerning only the mammals which concluded that Lollikhuse showed evidence of year-round occupation.

Muldbjerg*

Muldbjerg is a TRB site located in the Store Åmose, dating between 3770 and 3360 cal B.C., with the majority of dates falling within the ENI period (Noe-Nygaard 1995). This site was excavated by Jørgen Troels-Smith in the 1950s and 1960s with faunal materials being analyzed by Nanna Noe-Nygaard. This assemblage is dominated by roe deer, with the other two members of the big three much less common. In fact, almost no wild boar was recovered, and red deer are not similar only in find numbers to otter (*Lutra lutra*) but fewer in number to finds of beaver (*Castor fiber*). This is not typical. In other words, aside from hunting of roe deer, the assemblage appears to have been focused on the procurement of aquatic fur animals. A large number of birds were also recovered, including waterfowl, both duck-sized and swan-sized, as well as raptors. Ducks are the best represented. Occupation is determined to have been most likely in-between late April and late August (Noe-Nygaard 1995).

Nivågård

Nivågård is located in northeastern Zealand, north of what is today Copenhagen, and south of Helsingør along the Øresund coast. The bone material was excavated by Keld Møller Hansen of the Hørsholm Egns Museum and analyzed by Inge Bødker Enghoff (2011). A true køkkenmødding, the site dates to the last part of the Kongemose culture, and to the Ertebølle. As is typical on Zealand (Ritchie 2010), the material was dominated by members of the Gadidae family, particularly cod, and to a lesser extent herring and other species (Enghoff 2011). The bird remains consist of very few determinable specimens, with no single taxon represented to any significant degree. The mammal fauna are dominated by the big three, in particular roe deer, but also contains a few seals and some fur animals, including red squirrel (*Sciurus vulgaris*), beaver, fox (*Vulpes vulpes*), pine marten (*Martes martes*), otter, and wildcat (*Felis silvestris*) (Enghoff 2011). Of particular note as to the fauna of Nivågård is the site's typicality for the region in terms of its faunal remains, which exhibit all of the usual traits for the area; a dominance of red deer, roe deer, and wild boar as well as fish fauna dominated by Gadidae. Seasonality data indicate likely visits over the entire year, with the question of permanent occupation an open one (Enghoff 2011).

Ordrup Næs

Ordrup Næs is located near the end of a coastal peninsula lying between Nekselø Bugt and Sejerø Bugt, in northwest Zealand. Excavated in the fall of 1939 by C. J. Becker, the faunal material was preliminarily analyzed by Ulrich Møhl (Becker 1939). 70% of the faunal material is of wild animals, with the remaining 30% domesticated species, including cattle and several loose teeth from a sheep. The big three dominate, with red deer being the best represented. Seals and harbour porpoises also are present. While published before the advent of radiocarbon dating, Becker (1939) indicated that this site was Ertebølle based on lithic typologies, but clearly there is at least some Neolithic component at the site given the domesticates.

Præstelyng*

Located in the Store Åmose, this late Ertebølle settlement site dates to between 4320 and 3780 cal B.C., with most dates just prior to the beginnings of agriculture around 3950 B.C. (Noe-Nygaard 1995). This assemblage was analyzed by Nanna Noe-Nygaard at Copenhagen University. The assemblage is dominated by the big three, with roe deer being absolutely dominant, comprising approximately two-thirds of the entire bone material. Most of the other species present are small mammals and some fur mammals and domestic dogs, but not in any large numbers. The number of bird species found is large, and includes waterfowl and raptors, but no one species has more than a few individuals, except for the finds of several species of ducks. Of particular note is the presence of pelicans. Occupation between April and September is determined on a number of lines of evidence (Noe-Nygaard 1995).

Sigersted

Sigersted refers to a cluster of TRB sites south of the modern village of Sigersted, central Zealand, dating to both the Early and Middle Neolithic and excavated in the late 1970s and early 1980s. Materials specific to the earliest Neolithic, ENI were recovered from at least one refuse pit and occupation layer, and included at least several poorly preserved animal bones which were analyzed by Tove Hatting (Nielsen 1985). While restricted to just several s, cattle, sheep, and domestic pig were present within the assemblage.

Smakkerup Huse*

Of particular importance to this dissertation is Smakkerup Huse located in Northwest Zealand along the reclaimed Saltbæk Vig. Excavated by T. Douglas Price, all materials were waterscreened through 4mm mesh. The site is near geographically to the newly investigated sites in this dissertation. Further, some materials from the faunal collection from the site were included among the isotopic analyses. This settlement site was excavated in the late 1980s and 1990s and is dated generally to the late Ertebølle, from around 4800 to 3800 cal B.C. (Price and Gebauer 2005). Faunal materials were predominantly analyzed by Signe Hede as part of her Master's studies at Copenhagen University. A smaller component was identified by Tine Trolle-Lassen.

As is nearly always the case at EBK sites, the faunal material is dominated by the big three, red deer, roe deer, and wild boar. The best represented species is red deer, but it is almost equaled in abundance by roe deer and followed by wild boar. Fur animals are represented as well, including a number of species. Several sea mammals are present in low numbers, as are identified specimens of domestic cow, several of which were directly dated to approximately 3800 cal B.C. (Price and Gebauer 2005). Birds are present in low numbers, but include several types of species, including passerines, raptors, and waterfowl (Price and Gebauer 2005). Stemming from the faunal evidence, occupation is placed in the summer, fall, and winter, and possibly year-round (Price and Gebauer 2005).

Sølager*

While published nearly forty years ago, Sølager is of pivotal importance as it is a shell midden, and one of the very few sites that span the transition to agriculture on the Zealand (Skaarup 1973). Located in northwest Zealand, the site was excavated by Jørgen Skaarup and radiocarbon dates place occupation in the EBK, early TRB, and the middle Neolithic. It is the only published transitional midden from Zealand, an important fact because early cattle are present in early Neolithic layers at the site. Overall, the assemblage is limited in size, but the Mesolithic materials are typical, dominated by the big three, with roe deer the most common. Seals also are present in appreciable numbers. Of particular note is the relative abundance of dogs, which are the second best represented species. In the early Neolithic levels, domesticates appear in low numbers, with the rest of the fauna remaining largely similar to their representation to the earlier EBK levels. While not identified to species in most cases, the assemblage is also notable for the large numbers of birds, particularly waterfowl and swans (*Cygnus* sp.) (Skaarup 1973).

Spangkonge*

Spangkonge is another site in the Åmose that dates just to the cusp of agriculture. The site was excavated by Anders Fischer in the 1980s and analyzed by Anne Birgitte Gotfredsen in the 2000s. Artifacts stylistically place occupation to the EBK and the earliest TRB (Gotfredsen 2003). The assemblage is large, with over 2000 bones determined to species. Many species are represented, with the typical domination of the big three, in particular red deer, but also fur animals, and at least one domestic cow. Fish and birds are also present but less common. Seasonality data indicate summer visits to the site (Gotfredsen 2003). In all, evidence follows that from the other nearby Åmose sites, indicating similar economies at these locations.

Åkonge*, Nøddekonge, and Vejkonge

These three sites are considered together, as they are quite near to one another in the Store Åmose and are nearly identical in terms of almost all aspects of their assemblages aside from overall numbers of bones. Also excavated by Anders Fischer in the mid-1980s, these materials were analyzed by Anne Birgitte Gotfredsen in the 1990s and published (Gotfredsen 1998). These three sites are dated to the latest EBK, just prior to the transition to agriculture and were all located near the same lake which was visited from the early summer into the late fall. Red deer, roe deer, and wild boar dominate, with a focus on red deer. Of particular note are the hedgehog (*Erinaceus europaeus*) bones found with cutmarks, which unequivocally show their place in the food economy. Several bones from very early domestic cattle are also present, a finding underscored by their early date and unambiguous identification. However, while present, their numbers are exceptionally low, indicating their minor role in the economy of the site (Gotfredsen 1998).

Ølby Lyng*

Ølby Lyng is located on the eastern coast of Zealand, near the modern seaport, Køge. The site was excavated by D. Liversage in the early 1960s, and the faunal material was analyzed by Urich Møhl and published by him and Erik Brinch Petersen (Møhl 1971; Petersen 1971). The settlement site is a secondary deposit, with very little faunal material remaining in situ courtesy of a marine transgression. The faunal material is interesting as it is an early example of significant variability in resource use. As is usual, the fauna is dominated by the big three, with red deer being the most important terrestrial fauna. Of note are the large numbers of marine mammals, particularly those of the harp seal (*Phoca groenlandica*), which dominate the seal component, and grey seals. These animals were probably hunted from boats during their seasonal migrations (Møhl 1971). Ølby Lyng, thus, represents variation on the theme of assemblages dominated by the big three on Zealand and reinforces the ability of Ertebølle groups to take all available resources from their local environment (Møhl 1971; Petersen 1971).

Other early Neolithic Sites on Zealand

Reports from several other early Neolithic settlements from Zealand document several animal bones, but for the most part just report several bones, or one or two species as being present with no quantification otherwise. These include Manderup Søgård, Maglelyng XL, and Sandhuse Mose, all of which have animal bones present and are interpreted as being hunting and fishing stations (Koch 1998). Sandhuse Mose is listed as having horse, wild boar, red deer, tortoise, cattle, and mallard ducks present (Koch 1998).

Previously Reported Ertebølle and Early Neolithic Sites on Fynen

During the Atlantic period, Fynen was most likely attached to peninsular Denmark, or at least the separation provided today by the Lillebælt was reduced to the point where easy migration movement of even small prey species such as the roe deer would have been possible. Published biometric measurements of several species from sites on Fynen are closer in their dimensions to those from Jutland than they are to those from Zealand, hinting that the Funen material were probably from the same, or at least connected to populations on Jutland, while populations on Zealand were likely isolated (Richter and Noe-Nygaard 2003). This argument based on body-size disagrees with data obtained in this dissertation (Chapters 9 and 10). However, Fynen does appear similar to Jutland in terms of local extinctions, where aurochs, polecat, and other species are present in assemblages from Fynen and Jutland, but are absent on Zealand (Aaris-Sørensen 1980). Interestingly, it appears that in addition to faunal differences, cultural differences such as regional variations in the presence or absence of specific artifact types, or different forms of the same artifacts also persist between the eastern and western Ertebølle, separated by the Storebælt (Petersen 1984).

Agernæs*

Agernæs, located almost due north of what is today Odense on the northern coast of Fyn, was excavated by Anders Jæger of the Nordfyns Museum during the 1980s. The faunal assemblage was analyzed and published by Jane Richter and Nanna Noe-Nygaard (2003). Bone preservation is remarkable, in part due to the dumping of bone into water by EBK groups visiting the site. The material contains little beside terrestrial mammals. Apparently, fishing and marine hunting were not undertaken. The bone material is dated to approximately 4200 cal B.C., placing all visits in the latest Ertebølle, possibly separated into two periods of visitation (Richter and Noe-Nygaard 2003). In all, the site was visited on a highly seasonal basis, probably in April and May, and then again in October and November, with the possibility of another short visit in the late spring or summer (Richter and Noe-Nygaard 2003).

The assemblage is remarkable in that evidence strongly points towards a focus on the procurement of skins and furs. In all, juvenile and newborn individuals of several species are the primary age group recovered. Fur animals are highly represented. While the big three comprise a large proportion of all of the recovered materials, juveniles are predominant, a highly atypical situation. Further, 33 individual pine marten were recovered, a remarkable number for an EBK site. Also, there is clear evidence of skinning of multiple species. It appears that dogs were used to hunt fur animals and neonatal red deer and roe deer for their skins, probably in conjunction with trapping, and then were skinned themselves. This has been interpreted as a specialized locality for such activities (Richter and Noe-Nygaard 2003).

Møllegabet II

Møllegabet II is located underwater off of the north coast of Ærø, an approximately 90 km^2 island south of Fynen, near the town of Ærøskøbing. This dwelling site dates to the early Ertebølle, with occupation around 5000 cal B.C. Underwater excavations yielded a modest number of animal bones as well as fish remains. The site was excavated in the late 1980s and early 1990s by the Langelands Museum, and the faunal remains were analyzed by Lisa Hodgetts and Peter Rowley-Conwy (2004). Birds were not identified to species, and less than a hundred bones of mammals were determined. In general, from such a modest sample, little can be said aside from a general discussion of the material. The big three are the best represented species, followed by several fur species as well as seals and other marine mammals (Skaarup and Grøn 2004). Information on seasonality from the faunal remains is not reported.

Ronæs Skov*

Ronæs Skov is another of the underwater sites lying in coastal waters around Fynen. The locality was excavated in the 1990s and 2000s, and lies in the Gamborg Fjord, western Fynen. This mid-sized

EBK settlement is dated to the late Ertebølle, between 4400-4000 cal B.C. and consists of refuse dumped into water during the Stone Age from a now-eroded terrestrial settlement. The best represented species are the big three, with swine and red deer the most important species, followed by roe deer. Marine mammals, including several species of seal, dolphin, large whale, and porpoise were recovered. The whale bones showed clear evidence of human butchery in the form of cut-marks. In addition, fur animals of several species also were identified. However, all of these are recovered in very modest numbers and were probably not the focus of the economy at the site. Within the faunal remains, there is evidence of occupation in the summer, fall, and winter (Andersen 2009). Overall, the assemblage is rather typical for a coastal late Ertebølle site.

Sludegårds Sømose

In the 1940s, 17 wild boar mandibles were recovered in a very restricted area (less than one square meter) of Sludegårds Sømose, a site located on Fynen, approximately 30-40 km from Agernæs (Albrechtsen 1954; Richter and Noe-Nygaard 2003). Several domestic pig, sheep, horse, dog, and humans bones were also recovered (Albrechtsen 1954). The wild boar mandibles were well-preserved and show clear evidence of killing at the same time of the year. These remains represent variable age groups and show similar patterns of butchery. A radiocarbon date on one of the mandibles places its deposition at around 4000 cal B.C., at the end of the Ertebølle culture, although the contemporaneity of the deposition of the mandibles remains an open question. Another question is whether or not the mandibles were an offering or simply discarded also remains an open one (Noe-Nygaard and Richter 1990). While not particularly interesting in an economic sense, the deposit is a rare example of what may be ritual activity in the EBK.

Tybrind Vig*

The famous site of Tybrind Vig also lies underwater on the west coast of Fynen. The site dates to almost the entire Ertebølle period and consists of both settlement and refuse areas (Andersen 1985). Here, the first extensive underwater excavation in Denmark was supervised by Søren H. Andersen with the faunal material analyzed by Tine Trolle-Lassen. Preservation of all organic materials at this site is remarkable, with the full range of fishing equipment (boats, paddles, leisters) present, as well as woven material and the famous highly decorated paddle (Andersen 1985). In the assemblage, the big three are well-represented, with red deer and wild boar dominating. However, the most common species in terms of actual numbers of specimens is the pine marten and it, along with other fur mammals, were extremely important to the occupants at the site. Importantly, and partially due to their fine underwater preservation, the fur animals appear to have been deposited whole, indicating that while taken for their furs, these animals were not subsequently eaten (Andersen 1985). There is evidence of summer, winter, and autumn occupation (Andersen 1985).

Previously Reported Ertebølle and Early Neolithic Sites on Jutland

Jutland has yielded perhaps the most varied faunal assemblages from southern Scandinavia, due in great part to the variable find sites as well as the topography of the region during the Stone Age, which included much more extensive networks of island, particularly in the more northern parts of the peninsula. One of the hallmarks of the region is the highly variable bone preservation, even within a very small area. This is well-illustrated by the shell midden at Bjørnsholm and the nearby site of Rønbjerg Strandvolde less than five kilometers away. Bone is well preserved, albeit highly fragmented at Bjørnsholm while at Rønbjerg Strandvolde, no organic material was preserved at all (Bratlund 1993; Skousen 1997-1998). Another complication is that many sites remain unpublished or in preliminary report form and are inaccessible. On the one hand, peninsular Denmark has yielded the largest number of faunal assemblages that have actually been analyzed, and therefore represents one of the best opportunities for understanding variability in EBK faunal resource use. On the other hand, however, there are unfortunately very few useable faunal assemblages from the peninsula that date to the earliest Neolithic, making studies of the transition more challenging on Jutland proper.

Aggersund*

Aggersund was excavated by Søren Andersen in an attempt to understand and completely excavate one of the smaller sites representing EBK occupation over a short period of time around 3500 uncal B.C (Andersen 1978). It is one of the many Ertebølle sites along the Limfjord in northern Jutland. Faunal remains from this locality show a remarkable focus on bones of the whooper swan (*Cygnus cygnus*). The most common species at the site, there are more than twice as many specimens as the next best represented species, the wild boar. Aside from these two species, red deer, roe deer, and fur mammals are represented only in low numbers, with very few grey seal remains as well (Andersen 1978). As the swans are better represented than the mammals despite their more fragile bones, it can confidently be said that Aggersund may represent a specialized site for the catching of swans and indicates the utility of the species to Stone Age man (Andersen 1978). Seasonal occupation seems most likely between mid-October and mid-February (Andersen 1978).

Bjørnsholm

The shell midden at Bjørnsholm, also along the Limfjord, was excavated between 1985 and 1991 by Søren Andersen and Erik Johansen with the faunal material analyzed by Bodil Bratlund. The Bjørnsholm shell midden is one of the transitional middens, spanning the EBK to TRB and was occupied from ca. 5050 to 5530 cal B.C. (Bratlund 1993). The Mesolithic assemblage consists of primarily the big three, with fur mammals, sea mammals, domestic dog, and various seabirds, waterfowl and raptors all represented by far fewer numbers of bones. Seasonal information from the Mesolithic sample indicates at least occupation from the late winter to the late summer (Bratlund 1993). The Neolithic sample is much smaller, and, therefore, observations drawn from the sample are less conclusive. No taxon is represented by more than a few specimens, but identified species include both wild and domestic forms, including the big three, fur animals, birds, and cows, sheep, and possibly goats (Bratlund 1993). Seasonal data from this material is very tentative, but, inconclusively, may indicate summer and winter occupation.

Ultimately, it appears that the early Neolithic sample at Bjørnsholm continues the Mesolithic pattern of resource exploitation, with little change aside from the inclusion of few domesticates (Bratlund 1993).

Dyrholmen*

Dyrholmen is located roughly equidistant between what is today Århus and what is today Randers Fjord, Denmark. This kitchen midden was excavated by Therkel Mathiassen, and the bone material was analyzed by Magnus Degerbøl and published in 1942. The site dates to the early and late EBK and contains some early TRB materials (Enghoff 2011). The faunal material is quite large, and is dominated by mammals, very few fish, and some birds, most of which are swans (Enghoff 2011). However, the majority of remains are of the big three, other large game fauna, and some sea mammals (Enghoff 2011).

Egsminde

The shell midden at Egsminde dates mostly to the EBK with extremely limited occupation in the earliest TRB (Enghoff 2011). Located along the eastern shores of the Limfjord in northern Jutland, the material was excavated by Søren Andersen of the Moesgård museum and was analyzed by Inge Enghoff (2011). The fish material is extremely limited, dominated by cyprinids and perch. The mammal assemblage, also very small, is dominated by the big three. Dogs were present at the site (Enghoff 2011). Owing to poor preservation, this material is not particularly informative.

Ertebølle *(locus classicus)**

The site of Ertebølle which gave the eponymous culture its name, was first excavated in the late 19th century (Madsen et al. 1900). *Ertebølle*, dated to much of the EBK, is a shell midden located along the Limfjord in northern Jutland. The site is not transitional, and has no Neolithic component. The majority of the mammal material is bones of the big three, found in almost equal proportions. Fur mammals are present, including wolves, foxes, pine martens, otters, lynx, and wildcat. Low numbers of seals are also present (Enghoff 2011). No domestic animals save for the dogs are confirmed in the assemblage. A rather wide variety of bird species are present. Of particular note are the large numbers of velvet scoter (*Melanitta fusca*), a dominance notable not only for its specificity, but also for its similarity to the abundance of the same species at Havnø (Enghoff 2011; Chapter 7).

Flynderhage*

The Fynderhage site, dating to the EBK, was originally situated on a small headland a short distance southwest of the midden at Norslund, eastern Jutland. Excavated by S. Gabrielsen in the mid-1940s, the material was analyzed by Ulrich Møhl and partially published posthumously (Enghoff 2011). Mammal bones from the site are numerous, consisting of a spread of terrestrial and marine species. The most numerous taxon is wild boar, although red deer, aurochs, and roe deer are also abundant. Fur animals are also present. Of particular note are the relatively large numbers of pine marten, with polecat, fox, badger, otter, wildcat, and lynx also present. Notable numbers of both harp and grey seal were found. Some other marine mammals, including dolphins and orcas (*Orcinus orca*) also were taken by man. Birds were recovered in modest numbers, and consist of mostly cormorants and swans. The site yielded only a very small fish assemblage, consisting of only three taxa, spurdog, mackerel, and cod. Seasonality data are not reported (Enghoff 2011).

Hjerk Nor*

The bones from Hjerk Nor were published briefly by Tove Hatting and her colleagues in the 1970s (Hatting et al. 1973). The site stands as one of the very few examples (along with Agernæs) of what may be a devoted locality for the procurement of animal fur, although there is some question of how representative the sample is (Hatting et al. 1973). These doubts are due to the fact that all bones recovered come from an outcast zone in the water, in front of a shell midden which remains unexcavated (Hatting et al. 1973). The site is located along the Limfjord in northwestern Jutland and is dated to the EBK. The site was excavated by M. Reffsgaard of the Skive Museum. The best represented species in terms of number of bones is the wildcat, followed by red deer, wild boar, and aurochs in comparable numbers. Markedly absent is the roe deer. Other fur animals are also present in numbers more typical for an EBK site (Hatting et al. 1973). Further, wildcat remains show clear evidence of butchery, which in conjunction with the numbers recovered, indicates the role of the taxon for fur procurement at the site. Unfortunately, no seasonality data are available, but presumably the wildcats were killed while they had their thicker, winter coat.

Krabbesholm II

The Krabbesholm shell middens are actually two shell-heaps located in the southern reaches of the Limfjord, northern Jutland. Krabbesholm II, one of the pair, and was excavated by Søren Andersen, with material analyzed by Inge Enghoff (2011). Krabbesholm I was excavated much earlier in the 19th Century, but is of limited use given an inability to separate out the Mesolithic and Neolithic materials (Enghoff 2011). The Krabbesholm II midden is a stratified shell-heap, dating from the EBK until the TRB, with some layers assignable to the much later Single-Grave Culture (Enghoff 2011). Regardless of the long history of occupation, the faunal material, still is quite limited in scale, consisting of only 240 identified mammal bones from all time periods and all taxa (Enghoff 2011). Regardless, the mammal material is dominated by the big three, with some other species represented, including fur animals such as red squirrel, wildcat, pine marten, and fox. Very few birds were identified, but ducks and swans are clearly present. Some domesticates are also found, including sheep and goats, and possibly some domestic cattle. Of particular interest in the material is the presence of a subfossil bat, a first from the Stone Age in Denmark (Enghoff 2011). The fish bones from the midden consist of a rather large assemblage dominated by eel (Anguillidae), followed by three-spined stickleback and herring, as well as a number of other species (Enghoff 2011).

Lindegård Mose

This site was excavated by the Moesgårds Museum under the direction of Peter Lundby in 2003 with the faunal materials preliminarily examined by Anne Birgitte Gotfredsen. The site was excavated in the course of the building a new roadway north of what today is Århus, eastern Jutland. While the site dates from the Neolithic to the Iron Age, a purely early Neolithic component was excavated, yielding one of the very rare early Neolithic faunal assemblages from Jutland. While modest in size, the assemblage is interesting in that of the determined specimens, the majority is domestic varieties, with only a few wild specimens in evidence. Most domestic specimens were cattle, although sheep and goats were also recovered as well as domestic dogs. Of the wild species, most are red deer, roe deer, and wild boar, with a few aurochs, birds, and bears (Gotfredsen 2004b).

Lystrup Enge*

Lystrup Enge is a settlement located inside a small inlet on the northern margins of the Århus Bugt, near modern-day Århus. Excavated by Søren Andersen, B. Damsgård, and P.E.Damsgård, Lystrup Enge yielded bone material that was not well preserved, and is dated predominantly to the early EBK. The fauna were analyzed by Ulrich Møhl, Bo Kildeager, Liv Ljungar, and Inge Enghoff (Enghoff 2011). Many fishbones, absolutely dominated by members of the family Gadidae were recovered. Plaice-flounder-dab and many other taxa are present to a much lower extent. The bird remains are few, but varied in taxa, with no particular focus on any species. As is typical of EBK sites, the mammal material is absolutely dominated by the big three and other terrestrial game, including appreciable numbers of aurochs. Small numbers of fur animals such as red squirrels, beavers, foxes, pine marten, badger, otter, wildcat, and lynx are also present. However, Lystrup Enge is notable for its very atypical marine mammal component. Seals are not taken in any appreciable number, and small numbers of dolphins are in evidence, but the large outlier is the large numbers of bones from orcas. This is something not seen at any other EBK site and almost certainly represents a focus on the taxa as a marine resource.

Norslund

The EBK settlement of Norslund is located along the Norsminde fjord approximately 15km south of what is today Århus in eastern Jutland (Andersen and Malmros 1966). Eighty-five m^2 were excavated, producing a mid-sized faunal assemblage analyzed by Ulrich Møhl. The bones consist predominantly of the big three and aurochs, with red deer, wild boar, and aurochs represented to a nearly equal degree and roe deer less common. In all, the majority of the assemblage consists of these four species. A number of other taxa are present in much lower numbers, including several species of fur mammals, birds, fish, and marine mammals. In general, a large number of species is observed overall, but large game can be said to be the dominant components of the human economy at the site.

Ringkloster*

Ringkloster is a truly unique site of the EBK, as it is an inland, lakeside hunting camp in eastern Jutland (Rowley-Conwy 1994-1995). Excavated by Søren Andersen, the material was analyzed by Peter Rowley-Conwy. The assemblage is of prime interest for a number of reasons. First is its location, nearly 15 km inland from the nearest Stone-Age coast. The season of occupation is highly focused on the winter and the spring. The assemblage consists of large numbers of red deer, wild boar, and pine marten, with other species represented to a much lower extent. There are rather large numbers of juvenile and newborn red deer among the red deer sample. Many fur mammal species are present, including otter, wildcat, badger, fox, beaver and polecat, but the fur sample is absolutely dominated by pine marten remains. Body-part representation data indicate that specific parts of the large-game fauna dominant in the material were most likely extracted elsewhere, probably to the coast (Rowley-Conwy 1994-1995). Ultimately, this assemblage represents one of the few examples of a resource extraction site, from which red deer, wild boar, and pine marten furs were extracted as part of a logistic strategy of resource procurement.

Visborg*

The shell midden at Visborg is of particular interest to this dissertation as it is located only several kilometers from the midden at Havnø. The midden was excavated by Søren Andersen and was analyzed by Inge Enghoff (2011). Similar to Havnø, Visborg spans the transition to agriculture, and contains both Ertebølle and TRB occupation layers yielding both domestic and wild fauna. As a whole, the assemblage is dominated by terrestrial species, predominantly red deer, roe deer, and wild boar. Less common are a number of other species, including fur bearing mammals such as fox, wildcat, pine marten, and otter, as well as sea mammals such as harp seal, grey seal, and orca. The domestic dog is also present, as well as a number of small rodents that are probably not archaeological. The bird remains are of a number of species, but are dominated by swans. Of particular interest are the domestic species including domestic cattle and probably domestic pig. Aurochs are not found, but the majority of the *Bos* sp. must remain undifferentiated (Enghoff 2011). Enghoff mentions the sizeable Mesolithic and Neolithic *Sus* sample and assumes that Mesolithic individuals are wild and Neolithic are domestic but offers no further reasoning for this. I disagree with this assumption, as it baseless. There is no reason to believe that all the Neolithic swine must be domestic. Finally, although present, very few numbers of domestic ovicaprids are recorded, but they are present.

Vængesø III*

This shell midden lies on the east coast of Jutland, located on the Helgenæs peninsula and may have been on an island during the Atlantic period (Enghoff 2011). The material was excavated by Søren Andersen and analyzed by Inge Enghoff (2011), and dates mostly to the middle and late EBK with a very limited early TRB occupation. The majority of that which has been analyzed is Mesolithic in date. The material is very rich, consisting of numerous fish, bird, and mammal bones. Among the fish, members of the cod family dominate, but individuals are actually rather small in size. Other utilized taxa include herring and greater weever (Enghoff 2011). Birds also were recovered in numbers large enough for their abundance to be meaningful, and in this case include mostly cormorants in numbers suggestive of their specific utility at the site. Mammals are very atypical in their occurrence. The site represents one of the rare EBK examples where the big three collectively do not dominate the faunal material, but instead share nearly equal abundance with both fur animals as well as sea mammals. The material consists of about one-third big three, one third terrestrial fur animals including, red squirrel, fox, otter, badger, wildcat, pine marten and polecat, and one third marine mammals, including mostly seals but also dolphins and true whales (Enghoff 2011). Keeping in mind that the site was also a shell-midden, and therefore consists of many, many thousands of marine oysters, the site represents one of the most varied and diverse faunal assemblages, probably owing to its location.

Yderhede

Yderhede, excavated by Per Lysdahl and Torben Nilsson, dates to the earliest EBK, from 5450 to 4850 cal B.C. (Christensen and Nielsen 2008). Analyzed by Inge Enghoff (2011), this settlement was on an exposed beach ridge along the open coast in far northern Jutland, in Skagen. The assemblage is small, but consists predominantly of the big three, with some fur mammals, including foxes, pine marten, and seals. However, the majority of non-big three species are represented by mostly teeth. Thus, it is difficult to ascertain the actual importance of these species at the site. Some bird bones also were recovered, but there were too few to make any major conclusions about the economy at the site. Fishing is documented by rather large numbers of fishbones, particularly those of the plaice/flounder/dab family (Enghoff 2011).

Åle

The shell midden at Åle also was excavated by Søren Andersen with the faunal material analyzed by Inge Enghoff (Enghoff 2011). This midden is located extremely near to the Bjørnsholm shell-heap, along the eastern shores of the Limfjord, northern Jutland. In fact, the two sites were probably part of the same midden-complex. As is sometimes the case at Danish shell-middens, the Åle sequence continues through much of the EBK into the earliest TRB. However, preservation conditions resulted in the severe under-representation of fish and bird remains and a limited mammal selection. The small assemblage contains mostly the big three, with some grey seals, fur animals including fox, otter, and wildcat, as well as limited domesticates including sheep, possibly goats, and cattle (Enghoff 2011).

Østenkær*

Also located in Skagen is the settlement at Østenkær, dating to the early EBK. This settlement is the northernmost EBK site and was excavated by Per Lysdahl with faunal analyses done by Inge Enghoff (Enghoff 2011). Much of the material from Østenkær was burnt, but as is typical at EBK sites, the material is dominated by the big three. Of these three species, red deer absolutely dominate, representing the majority of large game at the site. Also recovered were a spread of bird species including predominantly seabirds, as well as the extinct great auk. All three species of swan are present. Three species of seal are found as well, in addition to a number of fur animals including foxes, pine martens, otter, and wildcats, some with cutmarks from skinning. Modest numbers of fishbones, dominated by whitefish, were recovered (Enghoff 2011).

Previously Reported Ertebølle and Early Neolithic Sites in Sweden

Sites in Sweden have an interesting distribution, not necessarily connected to anything relating to human activity in the past. In general, the pattern is of reported EBK faunal assemblages from Scania, but larger early Neolithic assemblages are almost all from eastern Sweden, in particular many from Uppland. The few ENI sites from Scania are mostly unuseable for economic discussions as there is evidence of purposeful deposition of particular species and particular parts of animals as is the case at Almhov (Macheridis 2011). Further, there are few transitional sites, and no reported transitional shell middens, giving a very incomplete picture of the very pivotal transitional period in the area. Nonetheless, the fact remains that the purely ENI sample, even though it is from eastern Sweden, is larger than that from all of Denmark, and is therefore of paramount interest for understanding the transition. The most important and largest sites are reported below.

Anneberg*

Anneberg is located quite far from most of the sites under consideration here, but is of interest for several reasons. Located in Uppland, eastern Sweden, the assemblage from Anneberg represents one of the few early Neolithic assemblages that have yielded a sizeable faunal assemblage. In fact, the fish collection is the largest recovered from Stone Age Sweden (Segerberg 1999). An example of a shore-facing site from the ENI TRB, the assemblage is the largest among a number of similar sites, and therefore, is probably the most representative of them (Hallgren 1998). The site was occupied between 4000 and 3750 cal B.C., and was excavated by Anne Segerberg, with the faunal analyzed by Per Erickson (Segerberg 1999). The assemblage consists of over 30,000 fish bones, mostly consisting of perch, but also pike and fish of the carp family. Other taxa of fish are extremely rare (Segerberg 1999). Birds are few, with several species of waterfowl represented by only small numbers of specimens. The mammal faunal material is dominated absolutely by seals, consisting of at least three species, with far fewer specimens of other taxa. Domestic animals are represented by cattle and ovicaprids. Wild large-game are rare, represented by only a few individuals. Fur animals are similarly rare, but include badger, fox, wildcats, red squirrel, hare, beaver and otter (Segerberg 1999). Ultimately, while an agricultural way of life is in evidence in terms of domestic animals, it is clear in this assemblage that an absolutely substantial component of the economy at the site was still based on wild resources, particularly seals.

Bökeberg III*

The EBK site at Bökeberg III has been dated to the late Kongemose, early Ertebølle, and late Ertebølle and is located in inland southwestern Scania (Regnell 2001). The site was excavated by the University of Lund, and the fauna analyzed by Eriksson and Magnell (2001). The faunal assemblage consists of many fauna, with the fish dominated by pike and bream, and bird bones including several species of waterfowl, including ducks, cranes, and swans, as well as some raptors (Ericksson and Magnell 2001). The terrestrial fauna include predominantly large game, especially red deer but also elk, roe deer, wild boar, and some fur animals, including pine marten, badger, beaver, fox, otter, and red squirrel. Bear and wolf (*Canis lupus*) are also represented (Eriksson and Magnell 2001). Season of occupation is long, stretching predominantly from spring through winter, with the presence or at least activities of people over much of the year (Ericksson and Magnell 2001). Of particular note at the site are the studies of skeletal-part representation, which likely indicates all parts of the animals present upon deposition (Ericksson and Magnell 2001).

Karleby Logården*

Layers B and C at Karleby Logården in western Sweden date to the ENI, and represent one of the few, large assemblages available from the TRB in that region. Animal bones were examined by Leif Jonsson, and consist of predominantly terrestrial species, mostly domestic animals. Among numerous unsure determinations, the best represented species attributed to a single taxon is domestic cow, followed by swine, and some domestic sheep and goats. Wild animals are very limited in occurrence and are represented by a few bones of wild fur animals, and deer. Birds and fish are present, but not determined to species (Sjögren 2003). The overall picture is one of probable dominance of domestic species, and indicates substantial agricultural activity at this time in this area of west Sweden.

Skateholm I* and II*

The Ertebølle settlement sites at Skateholm dating to the EBK, are both located near to one-another in what was probably a protected cove along the southern coast of central Scania, Sweden (Jonsson 1988). Both sites are dominated absolutely by the big three, with wild boar the most common species at Skateholm I and roe deer most common at Skateholm II. Both assemblages contain a substantially diverse, but limited bird sample with many species but none in clear dominance. These include waterfowl and raptors. The rather homogeneous fish assemblage at both sites is characterized by a nearly complete dominance of perch. Sealing was important at both sites, with several species represented. Fur animals were also trapped or hunted, including wildcat, otter, badger, red squirrel, pine marten, foxes, and beavers. Seasonal information places occupation throughout the year, and the overall impression is of great diversity of prey, indicating that EBK hunters at the site were able to take numerous and diverse available resources (Jonsson 1988).

Skjutbanorna

This site was excavated in the 1990s under the auspices of the Öresund Link Project, archaeological investigations prior to the building of the Öresund bridge linking Zealand with Scania. Correspondingly, the site is located on the western shores of southern Scania, facing the Øresund and Denmark. Multiple radiocarbon dates place occupation in the late EBK and the early TRB, roughly between 4200 and 3700 cal B.C (Jonsson 2005). The economy at the site has been interpreted as a fishing and hunting camp, probably visited over the whole year. Fish remains were dominated by cod, among 11 species of fish recovered in all. Very few birds were in the assemblage, but comprised five species. Numerous species of mammal were present as well, but in relatively small numbers. Wild species included the big three, as well as fur animals such as red squirrel and wolf. Seals, mostly grey seals, are present, and domestic species are represented by ovicaprids, mostly cattle, and some domestic pigs (Jonsson 2005). While rather small, the assemblage paints a similar picture as to other transitional sites elsewhere.

Skumparberget*

Similar to Anneberg, Skumparberget is located in eastern Sweden, quite far from the other sites under consideration here. Nevertheless, the site dates to the ENI TRB, and warrants inclusion owing to its large sample size among other published contemporary localities as well as its strong contrasts with sites similar to Anneberg where sealing was a main activity (Hallgren 1998). A number of other sites are located nearby (see Hallgren 1998), but Skumparberget is the assemblage most likely to give an accurate portrayal of resource use due to its larger size. Despite being contemporary with Anneberg, Skumparberget represents a land-facing inland site, and therefore has an opposing focus in terms of faunal resources exploited. At this locality, significantly, the fauna is completely dominated by domestic species, particularly cattle but also sheep, goats, and domestic pig. Other scant finds are exclusively fur species and seals. In addition, fish remains are also very rare. Taken in conjunction with similar land-facing sites, and in contrast with Anneberg and other shore-facing sites, it is clear that a dichotomy of site types does exist during the ENI in the region.

Previously Reported Ertebølle and Early Neolithic Sites in Germany, Poland, and on Bornholm

Due to isostatic rebound (Mertz 1924; Christensen 1995), many of the Ertebølle sites in northern Germany are located underwater or are simply gone. As a result, the available data were largely incomplete prior to the last two decades, with terminal Mesolithic assemblages often incomplete, or unclear in terms of their ability to be interpreted (Hartz and Lübke 2006). In fact, knowledge of Mesolithic culture prior to the EBK is virtually unknown in northern Germany, and little is known about the earliest Neolithic on the north German Baltic coast outside of Schleswig-Holstein. However, there is ongoing research on the island of Rügen and further west that is shedding light on the situation (Hartz and Lübke 2006; Hartz et al. 2007). Nonetheless, since the 1990s, underwater research, particularly in and around the Mecklenburg Bay area, have significantly clarified the situation, not only chronologically relating to the transition or appearance of the TRB, but also to the degree of intensity of the earliest Neolithic and the faunal economy at this pivotal moment in time (Hartz and Lübke 2006). Ultimately, the centers of research concerning the EBK and early TRB are restricted in Germany to the Mecklenburg Bay and the island of Rügen.

Unfortunately, very little data are available concerning subsistence on Rügen. However, some data about subsistence and human practice can come from even very small faunal samples, such as the sand-dredged assemblage from Drigge, Rügen. This small collection of almost entirely red deer and recovered human skull fragments yielded evidence of cutmarks and potential cannibalism (Terberger 1999). Similarly, the site at Lietzow-Buddelin, also on Rügen, dates to around 4300 cal B.C. Its assemblage yielded European perch and seals (Schmölcke 2005). Ultimately, the best assemblages for understanding EBK and early TRB subsistence in northern Germany come from the Mecklenburg Bay area. Herein the largest and most interesting faunal assemblages from that area will be discussed in-turn.

Grube-Rosenhof and Grube-Rosenfelde

These sites are located along the northern shore of what is today Mecklingburg bay, Schleswig-Holstein and is dated to the early EBK, roughly 5000-4800 cal B.C. and the middle EBK, roughly 4800-4600 cal B.C. respectively (Schmölcke 2005). Both sites were excavated by Sönke Hartz and analyzed by Ulrich Schmölcke. The Rosenhof assemblage contains a large number of fish bones which are dominated by Atlantic cod. The mammal assemblage consists mostly of the big three, with some seal, auroch, and otter remains (Schmölcke 2005). Of particular note, one specimen was tentatively identified as a domestic cow and was radiocarbon dated to 4600 cal B.C. The assessment of this extremely early domestic animal is probably erroneous (Noe-Nygaard et al. 2005; Schmölcke 2005). The Grube-Rosenfelde site similarly yielded not only red deer, roe deer, and wild boar, but also aurochs, and some eel bones.

Neustadt*

Neustadt is an underwater transitional EBK-TRB settlement site located near the modern-day city of Neustadt in northern Germany, about 20 miles southwest of the modern day city of Kiel. Numerous radiocarbon dates confidently place occupation over the course of the transition to agriculture in the region (Glykou 2011). Both ceramics and faunal materials were analyzed by Aikaterini Glykou. The assemblage is notable primarily for two reasons: first the absolute dominance of seal remains as the main prey and second the presence of domestic species among the remains (Glykou 2011). Seals of four species are present, in addition to the harbour porpoise. The terrestrial game are dominated by the big three, with some aurochs, indeterminable cattle, and elk as large-game prey. Fur animals are also represented by a number of species, including otter, beaver, pine marten, wildcats, badger, fox, polecat and lynx. Several other species are present, but in low numbers. Also notable are the domestic animals, including a few confidently identified sheep and domestic cattle. The extremely low numbers are due to the difficulties separating wild from domestic congeners.

Schlamersdorf (Travenbrück)

Schlamersdorf, notable as it is one of very few examples of an inland site from the EBK in Germany, is located in Schleswig-Holstein and excavated by K. Bokelmann and S. Hartz (Hartz 1991, 1997; Heinrich 1993). The site is located roughly 20 km inland, west-southwest of the modern day town of Lubeck (Hartz 1997; distance my estimate). Occupation is dated to much of the EBK, between approximately 5500 and 4000 cal. B.C. (Hartz 1997). The fauna, analyzed by Dirk Heinrich, provide one of the very few opportunities for understanding inland EBK subsistence in the southern reaches of the EBK culture-area. The faunal are dominated by freshwater fish remains, followed by mammals, some birds, and a single amphibian. Most of the fish are northern pike, a freshwater and brackish species, but also include appreciable numbers of freshwater perch as well as carp. Birds are varied, including mostly waterfowl of a number of species, none dominating. Terrestrial mammals are few in number, but consist of red deer, wild boar and aurochs. No roe deer, and few fur animals including red squirrels, otter, polecats and wildcats are present (Heinrich 1993). In all, the picture is of local subsistence, with resources obtained and consumed locally.

Timmendorf-Nordmole I and II

Timmendorf-Nordmole I dates to the last part of the EBK, between 4400 and 4100 cal B.C. This underwater site was excavated by Harald Lübke and lies under a maximum of four meters of water. The faunal assemblage is dominated absolutely by fish bones which comprise about 95% of the recovered remains. This component consists of mostly eel, atlantic cod, and flatfish, among many other types. Mammals were represented by mostly roe deer, but also red deer and aurochs, as well as some seals of at least three seal species. Birds were exclusively waterfowl. Timmendorf-Nordmole II was dated to approximately 4900 cal B.C., and is located only several hundred meters from Timmendorf-Nordmole I in approximately seven meters of water. A final faunal report is not available, but eel are present in the assemblage (Schmöcke 2005).

Wangels*

This underwater site is another transitional location, dating both to the EBK-TRB which in northern Germany, occurs approximately 100 years earlier than in Denmark (Hartz and Lubke 2006; Hartz et al. 2007; Heinrich 1999). It is of particular interest given its transitional nature, its inclusion of domesticates alongside domestic species, its location, near to Neustadt, and its somewhat different faunal assemblage. The Wangels collection, somewhat smaller than at Neustadt, consists of a number of wild and domestic species, including the big three. However, of the mammalian fauna, the majority is domestic, including, in particular, cattle but also some sheep and goats and domestic pig. Fur animals are incidental in their representation, including only stray finds of otter and pine marten. Seals are similarly rare. The fish assemblage is small, and consists of many species, each represented by only a few specimens. The same is true of the birds, which are represented by waterfowl, and a few raptors.

The Polish site, Dabki

Dabki is the sole faunal assemblage available from Poland published in the international literature. The site dates to the EBK, or a Polish permutation of the EBK, and to the earliest Neolithic along the Baltic coast of Poland (Ilkiewicz 1989). Dabki is located approximately 100 miles east of the German island of Rügen, near the modern-day Polish town of Darłowo. The site was excavated by the Koszalin regional museum. The fauna were analyzed by Marian Iwaszkiewicz and Marian Sobociński (Ilkiewicz 1989). In addition to being the only assemblage available from Poland, the material is notable for several reasons. First, more than half of the mammals are beaver, a unique situation within the EBK.

Second, the material is notable due to the presence of domestic species, including cattle and domestic pig in not insignificant numbers. In addition, other fur animals are represented to a low degree, including badger, pine marten, wildcat, otter, fox and red squirrel. The big three are present, as is other large-game, but in all they probably did not contribute to any great degree to the economy at the site. Sea mammals are present in the form of seals, and other rare species including horse, wolf, and bear are also present. Birds include a number of species, particularly waterfowl. Raptors also are present. The fish assemblage is dominated by pike, perch, and bream (Ilkiewicz 1989). The domestic fauna, including cattle and wild boar, appear to increase in abundance and possibly importance incrementally over time, starting as a low percentage of the assemblage and steadily rising in successively younger levels.

Grisby, an Ertebølle site on Bornholm

Published faunal materials from the Bornholm EBK are limited to one site, Grisby, located on the eastern coast of the Baltic island. This locality dates to the last three hundred years of the Ertebølle (Petersen 2001). The assemblage is comprised, in almost equal proportions, of wild boar, seal, and harbour porpoise, with very little else (Petersen 2001). Of particular interest is that based on the finds, a small population of deer may have been resident on Bornholm at the end of the Atlantic period, and that wild boar probably were able to resist hunting pressure and were probably present in large numbers during the EBK on the island. No information about seasonality is available, but the data seem to indicate a unique adaptation most likely predicated by the geographic setting of the island of Bornholm.

Sites in this study

For this dissertation, the primary analysis of four faunal assemblages was performed. Two of these assemblages have been reported (at least partially) previously, both by the Second Kitchen Midden Commission (Madsen et al. 1900) and in several publications concerned with various aspects of the sites not under consideration here (Andersen 2008; Ritchie 2010; Robson et al. forthcoming). For the most part, preexisting data relevant to the economic history of the sites are presented in the individual chapters concerning the analyses. General background information will be presented here.

Asnæs Havnemark*

Asnæs Havnemark is the subject of a forthcoming publication (Ritchie et al., in review). Some of the data presented in Ritchie et al. (in review) appears in Chapter 4 of this dissertation. The site is located on the north side of the end of the Asnæs Peninsula, one of two long, coastal peninsulas framing the modern-day Kalundborg Fjord. The site was discovered as it was eroding out of a beach ridge, a process of destruction which continues. Excavations were undertaken by the University of Wisconsin-Madison and the Kalundborg og Omegns Museum in the summer of 2007 during which $22m^2$ of a very rich cultural layer was exposed and recovered. The culture layer represents a terrestrial deposit framed by two episodes of beach-ridge formation, caused by the littorina transgressions. Deposits were primarily excavated by hand after having been exposed with a digging machine. Artificial spits were not utilized, and, instead, horizons were excavated and bagged separately as encountered. All materials were water-screened using water from the nearby Kalundborg Fjord through 4mm mesh.

Human occupation of the site was probably limited to two periods, around 4500 cal B.C. and 4100 cal B.C., just prior to the regional adoption of agriculture (Ritchie et al., in review). However, recovered ceramics are both late EBK and early TRB in type. The site is notable for the enormous amount of flint that was recovered, as well as its copious amounts of fish and animal bone. Fish bone are so abundant that a specific sampling strategy was employed, as picking the fish bone individually out of the screens would have been impossible for all squares (Ritchie 2010; Ritchie et al., in review). However, all non-fish bone faunal remains were collected. The majority of the bone material came from just three layers, the Culture layer, Shell layer, and Brown Surface layer, which yielded 89.1% of the bird and mammal remains that are attributable to species.

Fårevejle*

This shell-midden site is located in northwestern Zealand. In the Stone Age, the site was situated in the northwestern shores of the now-drained fossil Lammefjord, and was initially located approximately 30m from the shoreline (T.D. Price personal communication). The site was first excavated by the Second Kitchen Midden Commission and was published in part by Madsen et al. (1900). New excavations were undertaken in the summer of 2004 by the University of Wisconsin-Madison and the Odsherred Museum, and led by T. Douglas Price. The goals of excavations were to ascertain the extent of the midden and the stratigraphy throughout the midden by placing a trench through the entire shell-heap, perpendicular to the ancient coastline, and completing an extensive set of radiocarbon dates of the various cultural layers. In addition, explorations also were intended to elucidate a dark cultural layer behind the deposit and any outcast layers in front of the shell pile (T.D.Price personal communication).

The trench through the midden was two meters wide, and 20 m long, and was excavated in ten centimeter artificial layers, following cultural layers where appropriate. Excavation was executed largely by trowel, with all materials water-screened through 4mm mesh. Later extended by machine, the entire trench runs 51 m long and about two meters wide, with approximately 102 m^2 exposed. Within this, the midden itself extended in all about 11 m in width. Thus, the excavated shell deposits were around 22 m^2 in horizontal extent, and averaged around 80 or 90 cm in thickness. Within the midden, several features were discovered, including hearths and other cultural constructions such as pits.

A number of diagnostic EBK and MN TRB artifact types were recovered, particularly transverse points, flake axes, blade knives, scrapers and burins from the lower, Mesolithic layers in the midden and

Neolithic artifacts such as large transverse points and circular flake scrapers were recovered from the upper layers. The bones from the upper layers of the midden were less common, and more fragmentary. This probably is related to the fact that shells from the upper layers are far more fragmentary as opposed to the more complete ones from lower layers. Further, bones from outside the midden proper were also very poorly preserved and fragmented easily, probably due to the lack of $CaCO_3$ buffering provided by the shells within the midden proper. Also, during excavation it was noted that more bones came from the lower layers of the midden, and sometimes were found in small piles in these contexts. In all, these trends probably resulted in much higher fragmentation of the Neolithic materials relative to the Mesolithic materials, and simply larger numbers of preserved remains from the older, Mesolithic layers.

It is believed that the midden is attributable to the late EBK and ENII TRB or MNI TRB based on diagnostic artifacts such as flint and ceramics and based on 25 radiocarbon dates, all falling between 4465 and 2906 cal B.C. (T.D.Price, unpublished data). It is important to note however, that most dates from the site fall in the earlier half of the dating range, many prior to the arrival of agriculture around 3950 cal B.C. In addition, the majority of faunal materials fall within the Mesolithic layers at the site (Chapter 5). Therefore, the midden is predominantly Ertebølle in date.

Trustrup*

Trustrup is an inland lakeshore settlement. The site lies around 8km as the crow flies from Smakkerup Huse and exists today as a bog deposit. Excavations were undertaken first as test investigations in 2001, and followed by full excavation in the summer of 2002, led by T. Douglas Price in a joint venture by the University of Wisconsin-Madison and the Kalundborg og Omegns Museum. In all, across the test investigations and full mitigation, 47 m^2 were excavated. Most cultural materials were recovered from the cultural layer, a brown loam with snail shells. This matrix probably represents an outcast zone, formerly in the lake, in which trash was discarded and later was filled in as peat. All material was excavated by hand, generally following several discernible cultural layers where possible. All materials were water-screened through 4mm mesh.

Most of the ceramics are EBK-type, but several may indicate TRB occupation as well. Recovered flint tools also reinforce this view, indicating mostly EBK types. A single AMS date of 6184±42BP was obtained on a piece of red deer bone, placing occupation at around 3860±55 cal B.C., although given the problems with bone diagenesis at the site in this investigation (see Chapter 8), this value must be taken as tentative. The decision was made not to further date any materials from the site given the very poorly preserved state of collagen in the bone material as determined in the isotopic tests.

Havnø*

Havnø is located today on the northern margin of the modern Mariager fjord, eastern Jutland, just over five kilometers or so from where the mouth of the fjord meets the Kattegat. During the Stone Age however, the shell midden at Havnø was situated on an island of limited extent, approximately one-third of a square kilometer, about two kilometers from the nearest land out in the mouth of the fjord (Andersen 2008). Occupation was long, with previous data placing occupation from at least 5000 to 3700 cal B.C. (Andersen 2008). The midden was first excavated by the Second Kitchen Midden Commission in 1894 and published by Madsen et al. (1900). In the 2000s, excavations were resumed under the direction of Søren H. Andersen of Moesgård museum. As of 2012, approximately 150 m^2 have been newly excavated, starting with a transverse section through the shell heap, and expanding through the body and behind the shell-heap proper (Søren Andersen personal communication). During the course of these excavations, the 1894 trench was re-located. In general, the midden consists of a number of small piles of shells, deposited as individual events. In the older levels are almost exclusively large marine oysters, and in the upper TRB layers are smaller oysters, as well as cockles and mussels (Andersen 2008). Within the midden several hearths have been discovered. Bones are usually recovered in small groups.

None of the material from the midden was water-screened, although all materials were excavated very carefully by hand and subsequently dry-screened through 4mm mesh. Water-screening may not have improved recovery in this case, as the matrix was, in general, simply oyster shell. All finds were plotted in three dimensions, and if recovered in the screens, were assigned to quarter-square within each individual excavation unit. Further, each individual find was assigned a three or four character find code with provenience information particular to each specimen. Levels were not dug in artificial spits, but instead are excavated continuously, plotting all finds. As a result, combining the pattern of sequential deposition of individual piles of shells and the progressive excavation technique, the stratigraphic sequence of events is immensely complex, and it is difficult to separate out individual find codes as to probable cultural period without careful consideration of their placement within individual profiles. In some cases, this is simply impossible. Therefore, at present, only directly AMS dated specimens and few individual bone specimens have been attributed to a specific culture, and the vast majority of the remainder is of unknown age. Hopefully, in the future this picture will be clarified, but for now, much of the data, although ambiguous of age, can be confidently placed within the range of AMS dates for the site.

Of particular interest at the site is the dating of the early domesticates. In this study, there are four such analyses performed on domesticated animals, and two on wild species. Two cattle bones were AMS dated to 3639-3618, 3611-3521 cal B.C. and 3767-3651 cal B.C. (2 sigma ranges), an ovicaprid was dated to 3706-3639cal B.C. (2 sigma), and a sheep was dated to 3707-3626, 3594-3526 cal B.C. (2 sigma) (Appendix XI). However, the dates obtained alter the picture somewhat from previous publication (5000-3700 cal B.C.) (Andersen 2008), as these late ENI dates extend the whole range of occupation for the site from 5000-3500 cal. B.C. (see Chapter 7 and 8).

In addition, two new AMS dates were run on a seal (*Phoca* or *Halichoerus* sp.) and a domestic dog. The seal was dated to 4545-4444, 4421-4396, 4384-4374 cal B.C. (2 sigma), and the dog was dated to 4458-4351cal B.C (2 sigma)(Appendix XI). As both were eating entirely or nearly entirely sea foods (Chapter 8), these dates require a reservoir correction. Consuting the Queens University Belfast Reservoir Correction Database (http://intcal.qub.ac.uk/marine/), and utilizing the two nearest geographic corrections to Havnø, these dates are corrected to approximately 4114-3943cal B.C. for the seal, and 4027-3920 cal B.C. for the dog. These are not meant to be absolute corrections, but to give an impression of the general age of these samples, which in this case is most likely just prior to the arrival of agriculture in the region. These specimens are considered Mesolithic in age in subsequent chapters with the recognizance that the dates could be early Neolithic depending on the correction used

The Bone Material as the Result of Human Activities

In all EBK and TRB faunal assemblages analyzed, cited and compared in this dissertation, the bones were recovered from archaeological sites. The assumption is that they are there as the direct result of human action. In the zooarchaeological literature, this cannot always be assumed to be the case. Some of the most contentious issues in the discipline have been whether or not bone assemblages were accumulated through hunting, scavenging, or natural processes related to predator activity or some other factor unrelated to human actions (Brain 1981; Bunn 2007; 1986). It is not my goal to assess past EBK analyses in this sense, as I did not excavate at the previously published sites, and I am forced to defer to the original interpretations. However, there is no doubt that the subfossil assemblages that I analyze here were accumulated through the action of human groups. I note this with the exception of some of the rodents and amphibians which are dealt with on a case-by-case basis in Chapters 4, 5, 6 and 7.

As previously discussed, Asnæs Havnemark is a terrestrial deposit, Fårevejle and Havnø are shell middens, and Trustrup is a lakeshore settlement. All faunal materials were recovered in strong association with evidence of human activities, including large numbers of lithic remains, hearths, pits, and other evidence. This strongly indicts humans in the accumulation of the remains, and to most would indicate that the assemblages were present because of human action. This is further reinforced by clear evidence of the working, processing or otherwise modification of bone remains at all sites (Chapters 4, 5, 6, and 7). However, for the purposes of being thorough, I will provide further evidence why humans accumulated the bone assemblages.

This task is easiest at Fårevejle and Havnø, where bone remains were recovered from *inside* a human-constructed mound of shells, and given the stratigraphy, were deposited multiple times in its construction, conclusively demonstrating that the remains are there as the result of human action. Simply, there is no accidental, natural, or predator-caused process by which multiple depositions of prey animals at the same location could have occurred between repeated visits by human groups. The shell midden fauna are the result of human action in this regard.

As for Asnæs Havnemark and Trustrup, the only predator capable of killing any of the big three present on Zealand by the Atlantic period was the wolf (Aaris-Sørensen 1980). While extinct in Denmark from the 19th Century (Aaris-Sørensen 2009), wolves in Eastern Europe today will hunt and consume a spread of terrestrial species not dissimilar to what accumulates at EBK sites (Jędrzejewski et al. 2000). In particular, they will hunt and consume forest ungulates. However, they do not account for the remains found at Asnæs Havnemark and Trustrup. Wolves hunt in groups of few to several individuals, usually killing individual animals at a time and usually only one per day. In addition, kill sites are away from dens or resting sites, with prey killed at a location, and consumed there over a matter of time (Ballard et al. 1987; Jędrzejewski et al. 2000). Therefore, accumulation of the remains of multiple prey at a single location will not occur, as the kill sites themselves are not re-typically reused. The fact that multiple individuals of ungulate species were recovered at all sites analyzed here makes the accumulation of the material by wolves highly unlikely if not impossible.

In addition, other factors further discount wolves as causal. At Asnæs Havnemark, remains of terrestrial and marine mammals were recovered (Chapter 4). Even if wolves somehow were the cause of the presence of the terrestrial species, the sea mammals and fish cannot be explained except through other means. The combination of species makes accumulation due to predation impossible. While it may be argued that the large numbers of fish could have accumulated through natural processes (Noe-Nygaard 1987), the combination of fish with terrestrial mammals and marine mammals cannot be attributed to any one process, except procurement by man.

Finally, at Trustrup, animal remains were recovered from a culture layer which represents deposition in a lake which later became a bog. Wolves could possibly kill a deer on an ice-covered lake and in the spring the melting ice could result in the carcass being deposited in the lake, but this unlikely scenario would have to have been repeated numerous times at the same location in order to explain the assemblage. Another explanation could be a simple accident by which an animal fell through ice or wandered, wounded or sick, into water, but almost always single finds, these types of situations are rather common in Denmark (Noe-Nygaard 1987).

Conclusions

This section has served to provide prose descriptions of previous research concerning the middle and late Stone Ages in southern Scandinavia and to provide some background for the quantitative discussion that is presented in Chapters 9 and 10. In particular, this has included some background information about the EBK and TRB as well as the geological and human history of the region. The preceding discussion of individual sites is not meant to be exhaustive, but it is meant to be representative, particularly considering the choice of sites included in the analyses later in this dissertation. In general, several observations are relevant pertaining to the extant dataset. 1)The material is abundant. 2)The quality of reporting is highly variable. 3)The material was excavated by numerous individuals using multiple techniques.4)The question of agricultural origins is not answered, in spite of extensive research in the area. 5)The potential for bias is very high, and therefore cannot completely be mitigated. 6)This region represents one of the best possible opportunities for understanding variability in Mesolithic hunter-gatherer resource use and the subsequent transition to agriculture due to the enormity of the extant dataset.

Chapter 3: Methods

Introduction and Facilities

Like all lines of archaeological inquiry, Zooarchaeological and stable isotopic methods are limited by the record. Not all methods or techniques are applicable for each assemblage and of course, the true nature of an assemblage cannot be known prior to analysis. Therefore, all assemblages included here were initially analyzed with the same procedural approach. Only then, and if appropriate, were more specific methodologies applied. The estimate of taphonomic loss at Asnæs Havnemark and the differentiation of domestic cattle from wild cattle at Havnø are two examples of these supplementary analyses. Because of this, the methods described and justified in this chapter are those that were applicable at all sites, and in the cases where particular methodologies are site-specific, those techniques are described in the individual site chapter in question.

All sites and materials were examined either under the supervision of Nanna Noe-Nygaard of the University of Copenhagen or using methods learned under her supervision, at the University of Wisconsin Zoological Museum. All species identifications were performed utilizing side-by-side comparison with specimens of known taxonomic identification either at the Zoological Museum of the Natural History Museum of Denmark, the Department of Geography and Geology at Copenhagen University, or the University of Wisconsin Zoological Museum and augmented by specimens on loan from the Field Museum of Natural History in Chicago. Laboratory preparations for carbon and nitrogen isotopic ratio analysis were undertaken at the Copenhagen University Department of Geography and Geology's stable isotope preparation laboratory and the Laboratory for Archaeological Chemistry at UW-Madison. The University of Waterloo Envionmental Isotope Laboratory, Waterloo, Canada, ran the analyses.

Definitions

To avoid ambiguity, I use the following terms and definitions in reference to the bones themselves throughout this dissertation. "Bone" is a general term used to describe any osteological material recovered from the four sites. "Fragment" is used to refer to any bone from the collection that is not complete. “Specimen” is used to refer to any fragment or complete bone that has been identified to species or class of species as circumstance dictates. “Element” is used to refer to the specific part of the skeleton to which a bone, fragment, or specimen can be assigned. Finally, when referring to a bone, “determined” means attributed to species or class of species as defined below.

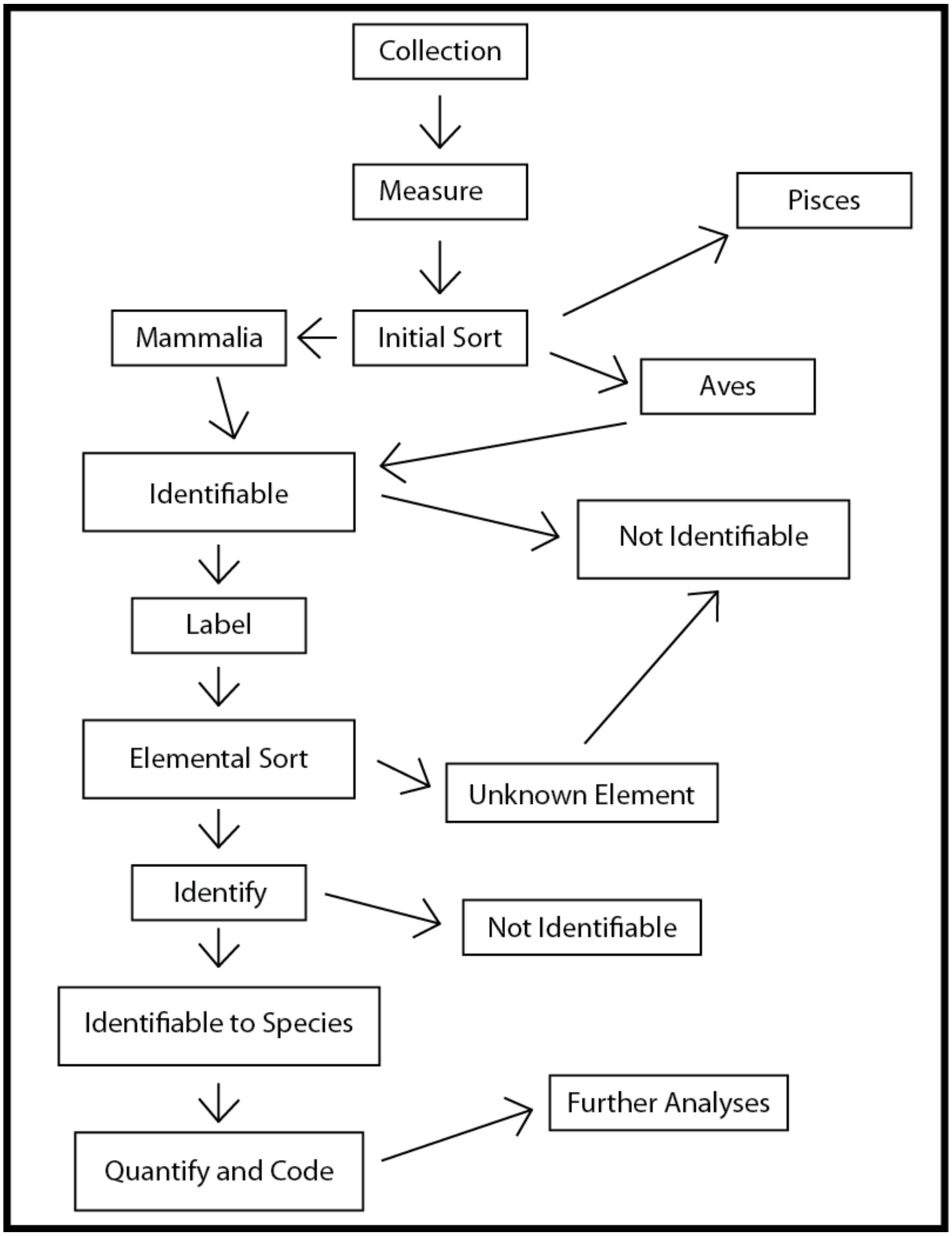


Figure 3.1: Flowchart of Zooarchaeological Methods

Prelminary Methods and Identification

A flowchart of the steps in the zooarchaeological analysis is seen in Figure 3.1 and a description of the analytical methodology follows. The initial step was to remove materials from their original bag, and to measure every bone's maximum length. These measurements were taken because the degree of bone fragmentation is one of the most important factors influencing quantitative recording of zooarchaeological data (particularly taxonomic identifications). The only real method of quantifying this directly is to measure and assign all bones to size classes (Lyman and O'Brien 1987; Marshall and Pilgram 1993; Outram 2004), although this method is not without its drawbacks (Outram 2001). Other methods are available to quantify fragmentation, including calculating an NISP:MNE (Minimum Number of Elements) ratio (Richardson 1980), simply calculating what percent of the total bones recovered were identifiable (Gifford-Gonzales 1989; Outram 2004), and zonation completeness methods (Gifford-Gonzales 1989; Outram 2004), but all of these methods have the major drawback for the purposes of this study in that they rely on the identified portion of the assemblage for their calculation, and even the least fragmented of the assemblages analysed here is highly broken-up, obvious upon even cursory examination. Therefore, these other methods have the potential to overlook a large proportion of the bone material. In addition, some authors (Outram 2004) advocate weighing of the size classes as well as measuring them, but the possibility of intra-site differences in bone preservation and weight at Danish Stone Age sites is real and unavoidable. An example of this can be found at Præstelyng, in the Åmose, central Zealand, where two tibiae, likely from the same domestic dog, had marked differences in weight due to being deposited in peat and organic mud respectively (Noe-Nygaard 1987). No materials were weighed for this reason.

All bones, complete or fragmentary, were measured by hand to maximum dimension, assigned to classes of one centimeter increments (e.g. 0-1 cm, 1-2 cm, 2-3 cm, etc.) and counted by physically placing and counting each fragment and whole bone, regardless of its ability to be identified, on 1 cm graph paper. At the low end of the smallest category, bones were included if they were identifiable as bone and were moveable by hand without the use of tools. These methods allow meaningful and quantifiable comparisons of degree of fragmentation from all sources to be made.

Materials were then sorted by hand, first separating material into three classes, fish, birds, and mammals. Bird remains underwent the same analytical steps described below for mammals, and fish were excluded because they were analyzed prior with the exception of those from Trustrup (Ritchie 2010; Ritchie et al., in review). Rarely, amphibians were encountered and were treated in the same fashion as the mammals and birds. In most cases, fish bone and human remains were partially handpicked out of the overall assemblages prior to this analysis. This is why these materials, when encountered, were set aside and not measured or included further, as the original extent of these materials in the assemblage was not known. The fish remains from Trustrup had not previously been analyzed so the small numbers encountered were identified by Ken Ritchie. Aside from this, no new fish analyses were undertaken, but all previous data from these sites is accorded full consideration (Ritchie 2010).

Mammal, bird, and amphibian material was then sorted further, separating materials with any diagnostic anatomical landmarks, any evidence of human human modification (including cutmarks, evidence of fracture, burning, working, etc.), or any evidence of post-mortem animal modification (such as gnawing) for further consideration. If not included in this category, the remaining materials were counted and set aside. All bones sorted as identifiable were then labeled physically on the bone. Each provenience, which in this case included individually labeled bags (usually with a level, square, a bag number, and other information which was recorded elsewhere), was assigned a bag number and a specimen number. Per bag number (and therefore per provenience number), each successive identifiable specimen was then assigned a sequential number.

Preceding each bag and specimen number, an abbreviation for the site name was assigned. Asnæs Havnemark was designated ”AH”, Fårevejle was designated ”FA”, Trustrup was designated ”TR”, and Havnø was designated ”H”. Thus, each specimen number encodes the site name, all provenience data for the specimen, and an individual number to separate it from the other specimens with similar information. The only exception to this rule were the specimens from Havnø, which instead of a bag number to encode provenience, a letter code assigned during excavations was substituted. For example, specimen AH7-8 means that the specimen is from Asnæs Havnemark, bag #7 the data for which is recorded elsewhere, and is the eighth specimen labelled from the bag. All numbers were recorded on the bone physically to encode these data.

The labeled materials were then sorted by skeletal element, following categories used by Enghoff (2009: 259). If not attributable to a particular element, fragments were treated as unidentifiable and placed with the unidentified material. At this stage, an attempt to refit fragments from like elements was undertaken. In the event of refits, reconstructed specimens were counted as a single specimen. All bone material determined to element was then determined to species. These determinations were made using side-by-side comparison with comparative collections housed at the Department of Geology and Geography at Copenhagen University and the National Zoological Museum of Denmark. Further comparative specimens were provided by the Field Museum of Natural History and the University of Wisconsin Zoological Museum. In certain circumstances, previously identified archaeological material from comparable and contemporary sites was used to enhance identification. For example, I used comparable sized, well-preserved domestic dogs from the Ertebølle site at Agernæs, Fyn, to confirm identification of dog specimens. Additionally, I used neonatal and fetal roe deer specimens also from Agernæs to confirm similar specimens from Fårevejle.

Some of the specimens were necessarily assigned only to class of species. While it might be easy to identify much of the unidentified material into arbitrary classes such as “medium mammal,” or “large mammal,” not much was to be gained by doing so in terms of understanding how any one EBK site is relatable to others. The best, most reliable comparisons obviously rely on confident taxonomic identifications. Therefore, assignment to a non-specific class was only done in circumstances when the nature of the material and the abundance of the material dictated. In most cases, this is because of multiple species in the same genus, all of which are very near to each-other morphologically. The classes of species used in this study are ovicaprid (*Ovis/Capra*), *Bos* sp. (in the case of Havnø), seal indeterminate, and *Sus scrofa* (in the single case of Havnø to describe either wild boar or domestic pig, here termed “swine”). The only other examples in which identifications to the generic level are used here are genera of birds that have numerous taxa, such as *Cygnus* and *Anas*. Further, this is not to say that specimens that fall within these categories necessarily must be assigned to them. If morphological features are such that species can be identified, identifications were made.

As an example of the difficulties encountered with some of the taxa that are grouped, seals are attributable quite easily to the family Phocidae; however four species of seal were present in the Atlantic period around what is today Denmark. Assignment to species is not often possible based on all elements (Storå 2001; Storå and Ericson 2004). In fact, such attribution is normally impossible. As marine mammals often are attributable to this larger class but not to species, the very different strategies required to obtain such resources, as well as the habitats where seals live, necessitate on an interpretive level, their inclusion as a class of species.

The ovicaprid class is used due to the importance of these species as early domesticates, as well as the profound difficulties separating the species without a few diagnostic elements. The class of *Bos* sp. is used at Havnø because of the presence of aurochs on Zealand during the Atlantic and Subboreal periods, the difficulties associated with separating aurochs and domestic cattle due to size overlap, and difficulties differentiating the congeners (Price and Noe-Nygaard 2009, Rowley-Conwy 1995). Such a problem is encountered only at Havnø, as no aurochs were present on Zealand at the time (Aaris-Sørensen 1980). Finally, similar to the problemsn with cattle, separating wild pigs from domestic forms (Rowley-Conwy 1995) is extremely difficult without very diagnostic measurements, none of which were possible in this highly fragmented material. Therefore, the class “swine” is used to denote *Sus* sp. congeners. A further discussion of these complications is found Chapters 7 and 8. With the above exceptions, if not confidently attributable to species or class of species confidently, bones were considered unidentified.

Aside from the cases justified above, mixed classes of species and unsure or tentative identifications are not included in this dissertation. For the purposes here, species either are, or are not attributed to a particular taxon. Tentative and unsure definitions add a level of incongruence between comparative analyses. The problem with these uses is that they introduce doubt into all comparisons between sites. For example, it is decidedly unclear what the actual difference is between a tentatively identified grey seal, a confidently identified seal (*Phoca* or *Halichoerus* sp.), or a tentatively identified seal (*Phoca* or *Halichoerus* sp.). Therefore, minus the exceptions discussed above, if I am unsure about a taxonomic identification, I err on the side of caution and list the bone as unidentified.

A Special Note About Limb-Bone Shafts and Bone Surface Modifications

Extensive literature and scholarship has addressed the various resulting biases from the inclusion or exclusion for various reasons of limb-bone shafts or other bones from zooarchaeological analyses (see Marean et al. 2004; Outram 2004). While inclusive of many time periods, most of the literature concerning this aspect of method focuses on pre-Holocene applications, particularly those concerned with early hominin hunting and scavenging, or identifying whether or not hominins were involved in the creation of fossil faunal assemblages (Marean et al. 2004; Marean and Assefa 1999; Pickering et al. 2003). However, consideration of this aspect of taphonomy is applicable and appropriate in assemblages from all time periods.

In order to minimize the effects of biases, *every* fragment of bone from the sites in question was screened and collected. All recovered bone passed across my laboratory table without any type of “field sorting”. While my initial sort of the materials here may be termed “selective study” (Marean et al. 2004: 75), I have been specifically and deliberately conservative in terms of my initial sort of the material. I included as “identifiable”, and therefore labeled and coded, any bone that exhibited any morphology whatsoever that could be used to determine the element, species, or further information about the taxon in question or human behavior, including any modification. In addition, all calculations of NISP, MNI, and other statistics explicitly *included* shaft fragments (and all bones attributable to species or class of species as outlined earlier) if I was able to determine the piece of bone to taxon.

Limb bone shafts, and all other bones I could not identify to taxon, were excluded from further analysis. This requires some justification and further discussion. A primary goal of this project was to ensure comparability with previous analyses. In this regard, the vast majority of published assemblages from the EBK and TRB list only NISP values for individual species (Chapters 9 and 10). In some cases, classes of animals, variable groupings of taxa, or size classes are employed, but there is no pattern to these applications (for example Bratlund 1993; Enghoff 2011; Glykou 2011; Gotfredsen 1998). Therefore, in order to compare relative abundances of species, in most cases, confident species identifications are required in order to make comparisons between sites. That is why I have focused on bones that can be attributed to species.

There is no defined standard in EBK or TRB zooarchaeology as to the inclusion, or exclusion of limb shaft fragments in quantification or derived statistics. As mentioned by Marean and collegues (2004) but also by others (Lyman 1994a), and particularly true of previous EBK and TRB analyses, terminology, methods, and exactly how quantitative statistics were derived remains at best variable and at worst undefined. In essence, it is unclear in most cases whether previous analyses of southern Scandinavian materials included or excluded limb shaft fragments, or what exactly was done to establish published quantitative statistics. I have chosen to include all bones in my determinations of these statistics, including limb shafts, in an effort to record, as accurately as possible, quantitative statistics and derived statistics for each individual taxon identified.

I have chosen to not consider further limb shaft fragments that are identifiable only as limb shaft fragments of undetermined element and of unclear species. As above, a primary goal of this project is comparability with previous analyses and this requires confident taxonomic identification of bones. To this end, further analysis of taxonomically unclear bones has no comparative purpose, even though analyses of this type can be very important (Outram 2001). In addition, in these analyses, but also in nearly all previous EBK and TRB analyses, the vast majority of assemblages consist of three taxa, red deer, roe deer, and wild boar (Enghoff 2011; Chapters 4, 5, 6, and 7). Correspondingly, fragmentary limb shafts that are not confidently attributable to species, but are identifiable as limb shaft fragments, in most cases almost certainly belong to one of these three taxa in most cases. In particular, wild boar and red deer limb shafts are largely indistinguishable visually in terms of longbone thickness, and overall size. However, grouping these in a category together for further analyses of selective transport, butchery, or other process is further limited by the possibility that wild boar and red deer were treated differently for transport, as they were at Ringkloster, and EBK site on Jutland (Rowley-Conwy 1994-1995). Therefore, using a grouped category is inadvisable, as any information drawn about butchery or transport from taxonomically unidentified bones could simply be wrong.

Finally, analyses of bone surface modifications have been accorded a position of high importance in zooarchaeological studies, even if the taxon of the bone in question is indeterminate. Studies of this type have been of particular importance, again, in the discernment of a human role in the accumulation of faunal assemblages versus that of other agents, such as carnivores (Domínguez-Rodrigo 2003; Fisher 1995; Olsen and Shipman 1988; Pickering 2002; Pickering et al. 2005 for example). This is not the only role of such studies, as they have also been applied to discern various aspects of human use of the resources represented by the bone remains through careful study of how they were processed (Noe-Nygaard 1989). In this dissertation, I note surface modification, but, aside from illustrative purposes in terms of proportions of the assemblages affected, largely do not further consider these factors. The primary reason for this is that in at least this aspect, the analysis was preliminary, as I had no idea what could be actually be accomplished with the material prior to analysis. The degree of fragmentation and the condition of the material is much higher and worse respectively than that from other locations, particularly the Åmose bog deposits (Noe-Nygaard 1995) and is therefore far less suited for studies of surface modification. In short, there is better material available for studies of butchery.

The assemblages studied here were chosen for their availability and for their proximity to one-another, not for the overall quality of the material. If that had been a consideration, this study would have been impossible. In all, the low occurrence of bone surface modifications at all sites, save for evidence of marrow fracture, combined with the variable degrees of preservation and fragmentation, made more exhaustive study of bone surface modifications impossible, and of unsure benefit for the purposes of this project. It is for these reasons that I chose instead to focus on the bones as body fossils (Noe-Nygaard 1989), and accessed the material as a measure of human activity instead through the lens of body-part representation and fragmentation.

Coding and Data Collection

After identification to species (or class of species where exceptions warrant), specimens were coded following a modified version of the rubric found in Redding et al. (1978) (Appendix I). This involved a step-by-step progression through a recording rubric in which multiple and various aspects of each bone were recorded. In all, there were up to 22 traits recorded for each bone specimen, varying with the type of bone, part of the body, and other factors between specimens. The various possibilities per criteria per bone specimen are listed in the coding rubric found in the appendices. Recorded traits included in all cases assessments of the species or class of species, element, bilateral symmetry, epiphyseal fusion, completeness of the specimen, the origin of fragmentation, an appraisal of the part of the bone represented by the fragment in terms of the percentage present of the original extent of the complete element, in the cases of teeth wear age and rooting, the relative ontogenetic age of the specimen, burning, disease, butchery, type of butchery, further comments, and associated specimens. Finally, at least one of the recording criteria is simply dictated by happenstance, that is, the comments section is simply to account for observations that may not be applicable anywhere else.

Each specimen was first identified to species, or class of species in the instances outlined above. Next, the element, or part of the body was recorded. Sometimes, this was a less-specific measure, as in some instances, elements were only identifiable to less-precise classes. An example is the metapodials from a roe deer, which could be from either the fore- or hind-foot if only a small part of the distal articulation is found. Teeth are recorded as accurately as possible, but not always to specific tooth. For example, the fragmentary teeth of swine easily can be identified as swine teeth, even when highly fragmentary, but it is much harder to pinpoint the individual type of tooth represented. The bilateral symmetry of the element was similarly recorded and was not always determinable. If the appropriate parts of the bone were seen, then an assessment of epiphyseal fusion was recorded. A general recording of the portion of the original extent of the complete element represented by the specimen was also made (0- 1/4, 1/4-1/2, etc.), assessing what fraction of the bone's original extent remained. The timing of observed fragmentation was assessed; whether breaks were old or the result of recent handling. Depending on the bone element, several measures of which specific parts of the bone were present were assessed, using various criteria and categories of recording (see Appendix I for categories). The degree of tooth rooting was recorded (see Appendix I for categories). Next, a general ontogenetic age of the specimen was assigned. Ages were grouped for analysis into three classes; neonatal, juvenile, and adult, as defined in Richter and Noe-Nygaard (2003:18). Neonatal specimens are bones that are incompletely calcified, are porous, and/or in which deciduous teeth are not yet in wear. Juvenile specimens have developed epiphyses that have not yet fused, juvenile teeth in wear, or unerupted permanent teeth. Adult specimens are those which have surpassed these criteria (Richter and Noe-Nygaard 2003). This general ontogenetic age was determined in order to coarsely determine the age of the specimens where otherwise more precise ontogeny may not have been possible.

Finally, the presence or absence of modification, burning, disease, and butchery marks were recorded and quantified for each specimen as to their type. Carnivore, rodent, or unatrributable gnawing was simply noted as absent or present at this stage, using examples and descriptors from Haynes (1980, 1983) and Lyman (1994b). In this case, the term gnawing is used to indicate any type of evidence of mastication on the bone surface. Butchery, working, or other intentional or unintentional postmortem human modifications were noted, and the general location and type was recorded according to terms presented in Noe-Nygaard (1989). Specifically, modifications including cut marks, blow marks from hammerstone percussion, and others, were identified visually and using a 10x hand lens, using descriptions of modification from Noe-Nygaard (1989) and comparative specimens. Burning was recorded according to the classes outlined in Redding et al. (1978), with assessments including both the extent and intetensivity of burning indicated by the color of the bone. General comments were made at this point if none of the preceding categories accommodated them, and any associated specimens or refitted specimens were also noted.

In addition to the general ageing of all specimens during coding, some specimens could be aged more specifically using various traits and criteria, such as bone porosity, general reduced size, and unerupted teeth. No ageing rubric was used. Only side-by-side comparison with specimens of known age was employed. No teeth were precisely aged unless there were at a minimum three teeth in-situ in a maxilla or mandible. In these instances, specimens were aged using side-by side comparisons with Danish materials of known age at death. Aside from teeth, precise ageing was not attempted unless there were several indicators of age on the specimen. An example of such a case would be a very small, porous, unfused longbone. Such a specimen would have numerous indicators of youth, and thus would be compared side-by-side with material of known age.

While many specialized ageing schemes exist concerning the attribution of age at death given toothwear or epiphyseal fusion in red deer, roe deer and wild boar (for example Bull and Payne 1982; Carter 1997, 2003; Noe-Nygaard 1987; Tomé and Vigne 2003), the highly fragmented nature of the material heavily influenced choices made in this regard. Resolution of toothwear-based ageing methods or tooth eruption methods increases with the number of teeth present *in situ*. In this case, the vast majority of recovered teeth were loose, and when found still in the mandible, teeth only very rarely were found in groups of three or more. Further, eruption schemes rely on specimens being complete enough to assess this aspect of ontogeny. In this case, fragmentary mandible specimens were nearly ubiquitously less than one-half of the original extent of the given element. As no toothwear schemes are available for maxillary teeth, this method was chosen explicitly to include both mandibular and maxillary teeth to expand the available sample size, and it is acknowledged that this was at the detriment of precision.

Quantification

To maximize comparability with previously described EBK and TRB fauna, methods of quantification are similar to those employed in previous analyses. Several faunal count statistics and their derivatives were calculated, including NISP, an estimate of MNI, and an estimate, per element, of the MNE for each species. Most previous studies in Scandinavia have included NISP values, and many more recent analyses include MNI or MNE values as well (Andersen 1975; Bratlund 1993; Enghoff 2009, 2011; Hatting et al 1973; Hede 2005; Hodgetts and Rowley-Conwy 2004; Johansson 1999; Jonsson 1988; Møhl 1971; Noe-Nygaard 1995; Petersen 2001; Richter and Noe-Nygaard 2003; Rowley-Conwy 1994; Skaarup 1973). Several quantitative methods are required due to the variability of collection size, preservation, degree of fragmentation, and recovery and analytical methodology. More than one method of quantification gives a clearer picture of just how economically important species were at all four sites. Also, this is standard zooarchaeological procedure.

For each of the general age classes, and for all species, NISP was determined (Payne 1975). MNI counts were established using the simplest method possible (Casteel and Grayson 1977; Noe-Nygaard 1977). This method involves side-by-side comparisons of all specimens identified to taxon in order to best estimate the original minimum number of individuals that is needed to account for the observed NISP. Neither NISP nor MNI are perfect metrics, and each application has its flaws in addition to errors stemming from inter- and intra- analyst variations in methods, skill, or other factors (Lyman and VanPool 2009; Payne 1985). For example, species can have distinctive numbers of bones, so even in a perfect world, where all bones are preserved, the death of a single pig individual and a single deer individual will result in the same MNI, but a different NISP (Payne 1985). In addition, I treat the assemblages as a unit, not quantifying MNI separately by stratigraphic layer, which also may be a source of error (Payne 1985), but is unavoidable given the variable depositional histories of the sites. Further, in highly fragmented assemblages, MNI tends to overestimate the abundance of rarer species, and the two metrics behave differently with the degree of fragmentation (Marshall and Pilgram 1993; Payne 1985). Nevertheless, I employ several statistics in order to approximate the relative abundance of species at the sites as best can be done given the quality of the bone material.

MNE values were calculated for each taxon by ignoring bilateral symmetry, and using side-by-side comparisons to establish the minimum number of actual complete bone elements required to account for what is observed (Bunn 1982). This methodology is commonly termed an overlap approach to MNE determination (Marean et al. 2001). These MNE values were then used to calculate %MAU for red deer and roe deer by dividing by the elements' occurrence in the mammalian skeleton, and then dividing by the most common value therein (Binford 1984). Appropriate to southern Scandinavia, this method is that used by Rowley-Conwy (1993-1994) and only slightly modified here, particularly in terms of which skeletal elements were included in the analysis. Carpals, most tarsals (except the astragalus and calcaneus), and phalanges as well as diminutive bones such as sesamoids, and caudal vertebrae were omitted from MNE, MAU, and %MAU calculations due to their often very small size and their potential to be overlooked during excavation and their association with larger, more diagnostic elements in the body. They are, however, considered for MNI and NISP values. Further, MAU and derived counts statistics were only informative for the best-represented species at all sites, which in this case was red and roe deer to the exclusion of the other species. At Havnø, *Bos* and *Cervus* data were grouped after MNE determination in order to calculate %MAU for larger taxa. Data manipulations are shown in Chapter 7 and 9.

MNE values were determined specifically for the calculation of Minimum Animal Units (MAU) and derived Percentage Minimum Animal Units (%MAU) values. Percent MAU values measure the relative frequencies of bones normalized for inter-site comparison. This is done in order to assess whether differential transport or destruction is evident as these processes affect the composition of bone assemblages (Lyman 1994a). These data are important because according to hunter-gatherer resource exploitation models (Binford 1980), body-part representation of particular species may differ between both site types and exploitation strategies, and this may be reflected in the archaeological record. While differences in methodological approaches can be problematic concerning these types of values and their derivation (see Lyman 1994a), comparison of the three sites is unproblematic because the same approach was consistently used. It is important to be explicit, however, that the derived MNI and MAU values used here do not indicate the same measure and are not calculated in the same fashion to the same end. That is, MAU and %MAU values indicate which specific bones were recovered from these sites, while MNI values simply give an impression of the minimum number of actual animals represented.

Body-Size Measurements

All specimens that were complete enough were measured according to von den Driesch (1976), which is standard zooarchaeological procedure. The widespread standardization of location and method of metric data collection in zooarchaeology allows measurements of skeletal elements to be used as a proxy for body-size (Jensen 1991). The most abundant metric data from the big three was compared to published metric data from the region in order to make comparisons concerning trends in body-size between regions of southern Scandinavia (Chapter 9). Any animal visibly younger than an adult, as per the criteria above, was omitted from the comparative discussion.

Seasonality

The presence or absence of animals at specific times of the year can be a useful tool for establishing the season of occupation at archaeological sites. As the Atlantic Period behavior of the species is not yet known with certainty, analogy with modern populations is the only recourse.

The seasonal presence of birds in Denmark today (Génsbøl 2006) was used to understand when archaeological materials were likely killed. In addition, several lines of evidence were sometimes available for the estimation of season of occupation based on mammalian remains. One method compares the antler casting stage of the archaeological examples of roe deer and red deer with the modern annual casting cycle (Mitchell et al. 1977; Sempéré et al. 1992). In addition, individuals under the age of one year can be used in seasonal assessments. Given annual birthing in most mammal species under consideration, individuals aged less than one year, in conjunction with the known biology of modern species, can be used to establish during what part of the year the animal died. Methods used for ageing are discussed above. Seasonal evidence from fish remains is taken directly from Ritchie (2010).

Weathering and Preservation

It is important to discuss taphonomic issues relating to the assemblage keeping in mind that not all of the bones originally brought to the site in prehistory were later recovered and identified for this project. While it is not possible to determine the precise degrees of loss attributable to scavenging, bone degradation, method of excavation, and other processes, some observations provide insight into the likely representativeness of the data. For each site, both qualitative and quantitative observations were made concerning the taphonomic condition of the bone. Qualitative observations included recording the general quality, color, and other characteristics of the bone. Weathering was quantified using Behrensmeyer’s (1978) scheme for the classification of weathering. Further, the bone was fitted into Nanna Noe-Nygaard’s (1995) descriptive categories for bone materials from the Åmose, as it is nearby to the sites under consideration here. The application of these three methods of quantification, one qualitative and two quantitative describes the bone and allows comparisons of the quality of the material.

Isotopic Studies

Any discussion of subsistence strategy must consider all the animals that were exploited. A major issue with understanding the roles of various classes of fauna at Ertebølle sites (i.e., fish, mammals, and birds) is meaningfully relating them to each other. While zooarchaeological units such as NISP and MNI are useful shorthand for reporting assemblages in a standardized format, they are not necessarily directly useful for archaeological interpretations. Because of the challenges inherent in using zooarchaeological data to study diet, isotopic studies of human (and dog) bone using the isotopic ratios of carbon and nitrogen have become increasingly popular. In addition, isotopic studies of wild and domestic fauna offer a complimentary view of the feeding environments of hunted species which can inform about similarities or differences in hunting localities, local environments, or widespread environmental change over time (Noe-Nygaard 1995). Isotopic studies are not without limitations, however. One difficulty with this approach lies in the use of multiple localities by individual groups of Ertebølle fisher-hunter-gatherers, resulting in isotopic studies of diet that reflect the average of visits to any number of sites over the course of the year. On a single-site basis then, it is probably impossible to determine how important the overall diet is in relation to what is recovered archaeologically at an individual Ertebølle site.

Carbon and nitrogen are both fractionated by the metabolic pathways of plants during photosynthesis and fixation and the resulting isotopic ratios are then altered as they travel through consumers and up the food chain (Tykot 2004). In this way, differences in the diet and position of a consumer in the food chain affect the isotopic ratios in bone collagen, and can therefore be used to determine broadly what is being eaten and from which environments. Plants that employ Calvin photosynthesis (C3 plants) and those that employ Hatch-Slack photosynthesis (C4) fractionate carbon differently, with a resulting and measureable effect on their isotopic ratios (Tauber 1981). Similarly, C3 plants and those living in marine environments show contrasting enrichment due to marine plants' assimilation of marine bicarbonate. Therefore, C4 plants have the potential to obscure marine signatures in isotopic ratio analyses. Fortunately, most C4 plants are restricted to airid environments, and are essentially absent in northern Europe prior to the adoption of agriculture (Tauber 1981). This means that the differences in marine versus terrestrial fractionation are observable and measurable in Stone Age samples and are a useful tool for determining diet in humans and other species (Fischer et al. 2007b; Tauber 1981). The isotopic ratios of nitrogen are most often used to determine at which stage in the food chain a consumer is feeding, enriched 3-5‰ per trophic level (Bocherens and Drucker 2003). These ratios, in turn, can then be used to determine the degree of omnivory in animals.

Bone collagen isotopic ratios can also vary depending on the degree of closure of the environment in which the consumer feeds. This is due to the differential recycling of ^{13}C-depleted carbon dioxide in variable forest strata resulting in the most negative δ^{13}C values found in leaves near the forest floor in closed, dark forests (Ambrose and DeNiro 1986). This is termed the canopy effect. In this fashion, the general type of environment in which herbivorous animals lived most of their lives can be accessed based on the isotopic ratios of carbon, as herbivores feeding in more open environments, such as grasslands, will exhibit more enriched $\delta^{13}C$ values than their deep-forest counterparts (Ambrose and DeNiro 1986; Noe-Nygaard 1995; Noe-Nygaard et al. 2005).

The purposes of these analyses were multifold. First, appropriate analyses on wild animals and dogs were taken at the individual site level in order to gain insight into the local environment around each individual site and to get an idea of human diet. Because analyses of fish remains from these sites already have been carried out (Ritchie 2010), it is vital to determine the proportion of the diet that comes from the land versus the sea. Further, accessing human diet is particularly important in light of the potential mixed terrestrial and marine subsistence strategies of the EBK and ENI TRB. Dogs are generally considered to be a reliable proxy for human diet in Stone-Age southern Scandinavia and are similarly used here (Clutton-Brock and Noe-Nygaard 1990; Fischer et al. 2007b; Noe-Nygaard 1988), although this application is not without problems (Eriksson and Zagorska 2003). Dogs were analyzed from each site save for Fårevejle, where no dog remains appropriate for analyses were recovered. Wild animals were analyzed from all sites, and domestic herbivores were analyzed from Havnø.

On a broader scale, in northwest Zealand, the purposes of these analyses were to obtain a spread of values and determine what the diets and environments of wild fauna were during the late Mesolithic. The multiple site approach was taken to determine how much variation may be expected from several sites in a targeted region. At Havnø, these analyses were not only to establish the local environment, but also to add domesticates in order to determine possible differences in diet between domestic and wild species within the Neolithic and also in conjunction with the Mesolithic sample. Ultimately, using data previously limited by low sample size, these analyses at that site were undertaken to illustrate the relationship between wild and domestic diets in the earliest Neolithic in south Scandinavia. Strictly on the individual site level, results are discussed in the relevant site chapters. Chapter 8 is a synthesis of all of the isotopic data.

Samples were taken only from recognizably adult animals (Noe-Nygaard 1995). Analyses focused on red deer, roe deer, wild boar, and dogs, but also included other terrestrial species, domesticates at Havnø, and a few marine mammals. Per site, appropriate samples representing distinct individual animals were analyzed, largely dictated by the collections themselves (e.g. by recognizably unique individuals, diagnostic elements, and character of the bone). Fewer specimens of other species also were run as appropriate and numbers of each species varied. For example, within the Asnæs Havnemark material there were not five individuals of each of the big three. The specimens from Smakkerup Huse were added to the study as all of the Trustrup samples failed due to a high probability of digenesis (Price and Gebauer 2005, Chapter 8). Additional samples were included from the TRB levels at Havnø.

Experienced laboratory technician Inge Juul and I prepared the isotopic samples in the isotope geochemistry laboratory at the Department of Geology and Geography at Copenhagen University using their standard preparation protocol. This protocol is based on that used by DeNiro and Epstein (1981), for the purification of collagen from subfossil animal bone. Samples were selected on several criteria, including gross weight (which may be an indicator of preserved collagen), bone overall preservation (bone that is too brittle likely has little collagen), number of specimens clearly from different individuals, size of bones available for testing, and specimen proveniences at particular sites. No values were used if they fell outside the ranges for acceptable atomic ratios of carbon to nitrogen (White et al. 2001). Hydroxylapatite analyses were not included in this study due to the potential for diagenesis, and therefore all dietary conclusions are based only on the protein component of the diet (Koch et al. 1997).

Comparisons

In Chapters 9 and 10, all available, appropriate, and compatible EBK and EN1 TRB faunal data from Denmark, Germany, Sweden, and Poland was integrated with data obtained herein to define the variability inherent in EBK faunal assemblages, to search for patterns among, and to understand the relationships between faunal remains and underlying causes of the human behavior behind their accumulation. Sample sizes used for comparison are based solely on what was available in direct conjunction with the number of sites and assemblages that were available for comparison. Justification for choice of sample size rests in the individual Mesolithic ad Neolithic Synthesis Chapters (9 & 10).

Conclusions

Methods used here were meant to be inclusive and exhaustive with the goal of gathering as much from the assemblages as possible about the economies and human behaviors at the sites in question. In particular, a special effort was made to keep assemblages comparable and to reduce ambiguity, a major problem with previous analyses. Methods were purposefully kept conservative so that all data are confidently collected, and where ambiguity exists, it is explicitly mentioned. Ultimately, the goal was to establish a strict, yet flexible framework for quantification of data so that the variation between sites and between the Mesolithic and Neolithic at Havnø could be confidently discussed.

Chapter 4: Asnæs Havnemark

Introduction

Asnæs Havnemark is located on the end of an approximately 10 km-long coastal peninsula in northwestern Zealand. No geographically similar site has ever been recorded from Scandinavia, and the fauna recovered from excavations reflect this unique location. . As a result, the site's location has the potential to affect not only the fauna recovered, but also interpretations about the economy at the site due to the restricted area from which terrestrial fauna derive. Unique finds, coupled with an atypical assemblage, make this site truly an outstanding locality for understanding the flexibility and diversity of EBK hunting practice.

The Faunal Material

In total, the faunal material from Asnæs Havnemark consists of 50,005 identified specimens. Of this, 47,760 (95.5%) are fish, 2214 (4.4%) are mammals, 29 (0.1%) are birds, and two (< 0.1%) are amphibians (Table 4.1). As amphibians are uncommon in the assemblage, and their economic use is questionable, they are not considered further. The cod family dominates the fish bone assemblage, while roe deer account for the vast majority of the mammal remains. Despite the preponderance of these two species, the assemblage presents an impressive variety of other fish, mammals and birds.

The identified mammals, birds, and amphibians are only part of the total 12,202 non-fish bones recovered from excavations. Of this total, and regardless of whether or not they were identified to species or class of species, 363 bones are birds (3.0%), 11,837 were mammals (97.0%), and two (0%) were from amphibians (Amphibia).

	Common name	**NISP**	**MNI**
Capreolus capreolus	roe deer	1493	19
Martes martes	pine marten	65	5
Sus scrofa	wild boar	141	4
Canis familiaris	domestic dog	119	4
Erinaceus europaeus	hedgehog	12	4
Cervus elaphus	red deer	122	3
Vulpes vulpes	fox	43	2
Castor fiber	beaver	21	2
Sciurus vulgaris	red squirrel	5	2
Lutra lutra	otter	5	2
Apodemus flavicollis	yellow-necked mouse	4	2
Phocoena phocoena	harbor porpoise	14	1
Felis silvestris	wildcat	2	1
Clethrionomys glareolus	bank vole	1	1
Arvicola terrestris	water vole	1	1
Phocidae	seal	166	5
Totals		**2214**	**61**

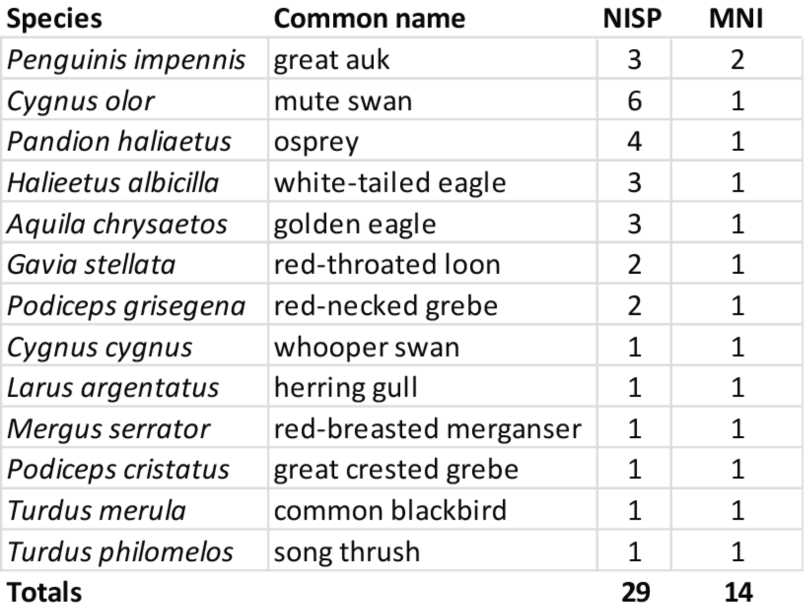
Table 4.1: Relative abundance data: mammals

Altogether, at least 17 species of mammal were recovered (Table 4.1). Highly fragmented mammal assemblages often are difficult to interpret due to the relationship between the degree of fragmentation and the quantitative nature of zooarchaeology (Marshall and Pilgram 1993). In this case, however, the overall picture of mammal use remains similar regardless of what statistic is used. This is a mammal assemblage dominated by roe deer with a broad representation of a large range of other species present in lesser numbers. All species are wild with the exception of the domestic dog, which is common to Stone Age sites (Aaris-Sørensen 1998). There are at least three species of marine mammals, including at least two species of seal and the harbour porpoise. Much of the seal material was not confidently identifiable to species, so seal specimens were assigned to the general class of "seal". However, this assemblage includes the grey seal and at least one member of the genus *Phoca*.

Roe deer comprise 66.5% of the identified material and a total of at least 19 individuals (MNI=19). Wild boar is the next most common mammal, making up only 6.3% of the assemblage and with a minimum of four individuals. Taken together, seals (Phocidae) comprise 7.4% of the identified material (MNI=5), and are the second most common mammalian prey. Both food species, as well as fur-bearing taxa, are represented. Among the terrestrial mammals, six taxa (beaver, fox, otter, pine marten, red squirrel, and wildcat) which are fur-bearing, are found, best represented by the pine marten, which, as with the seals, has the second highest number of individuals with a total of five (MNI=5).

Of the mammalian species, three, the bank vole (*Clethrionomys glareolus*), water vole (*Arvicola terrestris*), and yellow-necked mouse (*Apodemus flavicollis*) are often considered not to be archaeological remains when they are recovered at a Mesolithic site (Aaris-Sørensen and Andreasen 1992). In addition, these three species bear no evidence of human processing. The hedgehog represents a difficult case, as the species is one of the smaller mammals that may or may not have been utilized by man. At some Danish Mesolithic sites this species does exhibit clear evidence of human butchery (Aaris-Sørensen and Andreasen 1992; Gotfredsen 1998), but at Asnæs Havnemark they do not.

The only domesticated species in the assemblage is the dog, comprising 5.3% of the assemblage and an MNI of four. At Asnæs Havnemark, dogs probably were kept as hunting companions as was typical for the Ertebølle period (Aaris-Sørensen 1998; Richter and Noe-Nygaard 2003). In addition, however, one notable specimen is an arthritically fused right calcaneus and astragalus from a dog that would have been lame. This animal would have had limited utility in hunting and may be best interpreted as a favored companion, or rather, a pet.



Species	Common name	NISP	MNI
Penguinis impennis	great auk	3	2
Cygnus olor	mute swan	6	1
Pandion haliaetus	osprey	4	1
Halieetus albicilla	white-tailed eagle	3	1
Aquila chrysaetos	golden eagle	3	1
Gavia stellata	red-throated loon	2	1
Podiceps grisegena	red-necked grebe	2	1
Cygnus cygnus	whooper swan	1	1
Larus argentatus	herring gull	1	1
Mergus serrator	red-breasted merganser	1	1
Podiceps cristatus	great crested grebe	1	1
Turdus merula	common blackbird	1	1
Turdus philomelos	song thrush	1	1
Totals		**29**	**14**

Table 4.2: Relative abundance data: birds

Avian materials yielded 13 taxa listed in Table 4.2. The presence of each species of bird is determined by the finds of single or only several specimens. With the exception of the extinct great auk (MNI = two), all bird species are represented by an MNI of one. The birds can be characterized as waterfowl or birds of prey. Birds were likely taken either as a source of meat (waterfowl) or in the case of birds of prey, to procure feathers for fletching or bone for specialized uses (Clark 1948).

Fish

In all, 47,760 fish bones were identified, consisting predominantly of members of the cod family (Gadidae, 84.5%), and eel (Anguillidae, 9.3%), but representing 18 families of fish in all.

Some seasonality data are determinable based on the migratory nature of some of the fish caught. In particular the presence of garfish and mackerel strongly supports summer occupation at the site (Ritchie et al., under review). Further, isotopic studies on cod otolithis indicate winter, summer and spring catches of this class of species (Ritchie et al., in review). In all, the predominant species were likely caught by angling, but may have also been caught via net and other methods (Ritchie et al., in review). The fish sample is remarkable for its focus not only on just two families, codfish and eel, but also for its wide breadth of species.

Representation by Level

Consideration of horizontal and vertical variability of the faunal remains from the site shows remarkable uniformity. Three layers (Culture, Shell, and Brown) constitute the majority of the vertical provenience information for the samples. The vast majority of non-fish bones were confidently provenienced to the Shell layer, Culture layer, and Brown layers, representing 81.9 % of the identified mammal and bird collection. When exhibited as percentages of the bird and mammal faunal finds per level (Figure 4.1), no clear patterns of changing abundance of these classes of taxa are seen over the major periods of occupation at Asnæs Havnemark. Overall, all classes of faunal remains from the site show uniformity in their relative abundances across contexts. Therefore, it is reasonable to treat the assemblage as a unit, because there is remarkably little change over time.

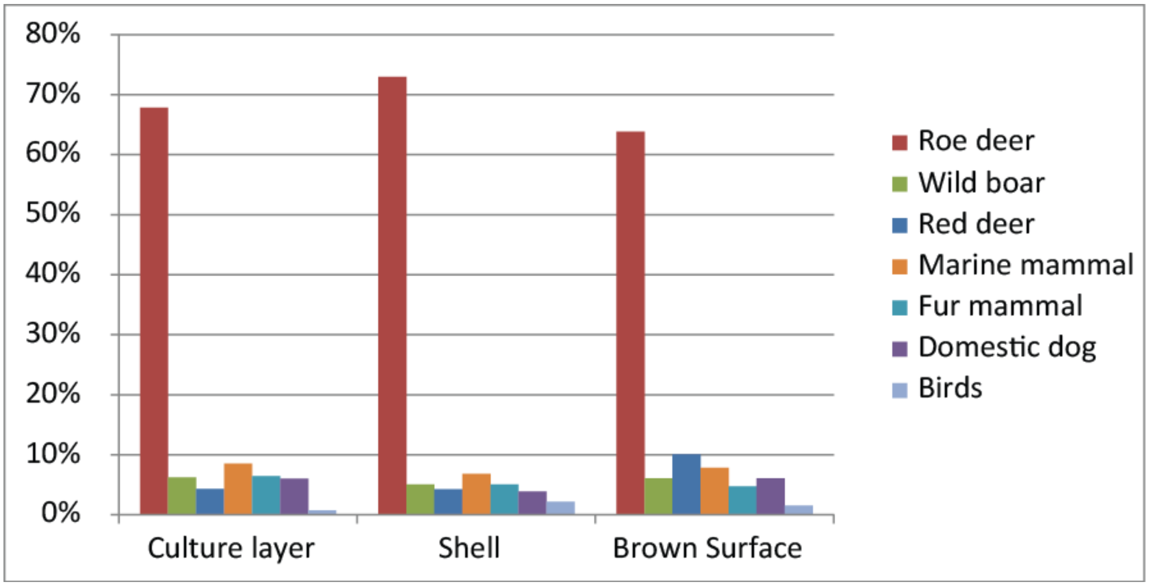


Figure 4.1: Representation by level of mammal and bird remains

Preservation and Taphonomy

It is important to discuss taphonomic issues relating to the assemblage keeping in mind that not all of the bones originally brought to the site in prehistory were later recovered and identified for this project. While it is not possible to determine the precise degree of loss attributable to scavenging, bone degradation, method of excavation, and other processes, some observations provide insight into the likely representativeness of the data. A qualitative assessment of the bird and mammal bones is that while largely fragmentary, they are well-preserved. Some bones are encrusted with a dark brown material. The effect of this can range from a very negligible impact on identification to total encrustation which precludes certain assignment to the realm of osteological artifact. Fortunately, these later cases were not common and generally the crust, when present, provided little hindrance to analysis.

The mammal bones show no signs of cracking or flaking, considered to be hallmarks of weathering due to exposure to the elements, although exfoliation has occurred on the surface of some of the bones. Therefore, the bone material from Asnæs Havnemark is a combination of Behrensmeyer's (1978) Category 0 weathering and Noe-Nygaard's (1995) Category 3 metric of bone preservation, leaning towards the higher limit of Behrensmeyer 0 and the lower limit of Noe-Nygaard 3. The comparatively light degree of weathering suggests that the bones did not lie exposed on the surface for long after they were deposited.

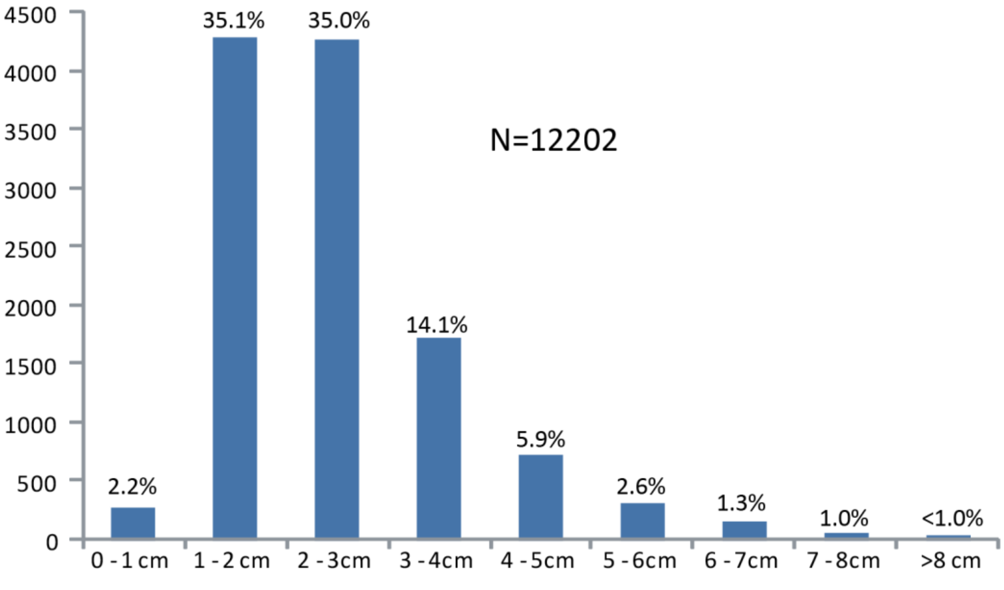


Figure 4.2: Maximum length of all bones recovered

As shown in Figure 4.2, over 70% of the material is between one and three centimeters in maximum length, supporting the assessment of a high degree of fragmentation. An estimate of taphonomic loss was undertaken only on the roe deer material as it is the best represented species and the single taxon for which it was possible to estimate the number of fragments resulting from the breakup of complete elements. Following Aaris-Sørensen (1983) and Noe-Nygaard (1977), the total taphonomic loss was estimated to be at a minimum 79%, based on an estimate of 375 fragments of bone per roe deer present at the site. It is acknowledged that the majority of the material of all species which was originally deposited was not recovered in excavations although taphonomic losses of this magnitude are common at other Mesolithic sites (Aaris-Sørensen 1983; Noe-Nygaard 1977).

Age Structure of the Finds

In total 50 specimens (2.2%) of the collection exhibit clear signs of being juvenile, determined by bone porosity, toothwear, deciduous teeth, or a marked and clear size below the adult range. Figure 4.3 lists tooth wear by specimen, and may include aged specimens of the same individual. Regardless, data are listed to illustrate the spread of ages. Only specimens of roe deer and wild boar were complete enough to assess age using toothwear.

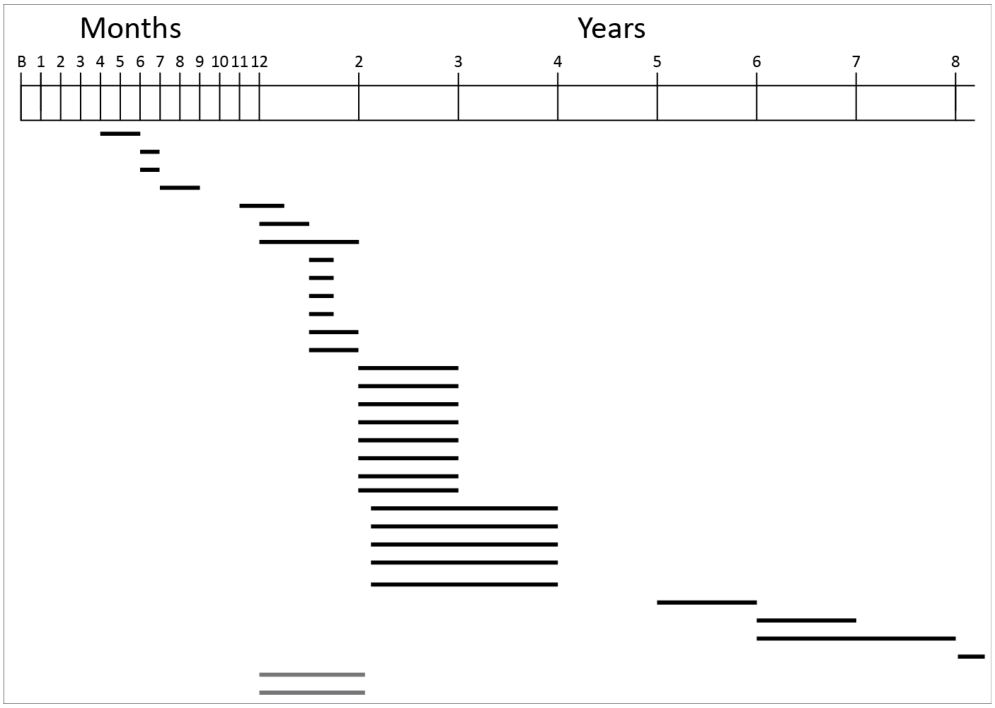


Figure 4.3: Ages of specimens based on toothwear (black=*Capreolus*, grey=*Sus*)

Two wild boar postcranial specimens were aged. These include a scapula attributed to an animal four to six months old and a mandible from an animal six to twelve weeks old. One roe deer calcaneus with undeveloped epiphyseal ends and extremely porous bone texture is indicative of a very young (less than ca. three weeks) or possibly a newborn individual. One final example of ageing involves the harbour porpoise. Among the material was the atlas and fused cervical vertebrae of the species, indicating an animal of at least six years old based on known rates of cervical fusion (Galatius and Kinze 2003).

In all, the sample is not large enough to interpret a mortality profile. However, it is clear that roe deer are represented by animals of all ages from juveniles to old individuals. The sample may, however, indicate a slight bias towards younger individuals. The assessable wild boar sample is small and no firm interpretations can be made except that both sub-adult and adult individuals are in evidence. The general picture of exploitation of these two species does not indicate focus on a single age class, although there appears to be a slight emphasis on younger individuals.

Season of Occupation

None of the 13 species of birds found at Asnæs Havnemark is represented by juvenile individuals, so it is not possible to use the timing of hatching to identify when the site was occupied. Instead, any seasonal information is restricted to the presence of individual species in conjunction with knowledge of their migratory patterns. The golden eagle (*Aquila chrysactos*), mute swan (*Cygnus olor*), white-tailed eagle (*Halieetus albicilla*), herring gull (*Larus argentatus*), red-breasted merganser (*Mergus serrator*), great crested grebe (*Podiceps cristatus*), red-necked grebe, and common blackbird (*Turdus merula*) present no information about seasonality due to the possibility of their year-round presence in Denmark (Génsbøl 2006). The song thrush (*Turdus philomelos*) must similarly be treated as a year-round visitor, because while it is usually present from late February until around November, some individuals stay in Denmark all year (Génsbøl 2006). The osprey (*Pandion haliaetus*) is present in Denmark in all seasons except winter. The whooper swan is an autumn, winter, and spring visitor to Denmark, present between September and April. Finally, red-throated loons (*Gavia stellata*) seasonally migrate through Denmark, present between March and May, and again between late August and November (Génsbøl 2006). To be conservative, no conclusions are made about the seasonal presence of the extinct great auk due to the paucity of observations made by naturalists concerning its migratory patterns before extinction (Bengtson 1988). Based on these observations, the bird evidence provides the possibility of site use in all seasons. Due to the fact that most bird taxa are represented by but a single individual, it is best to use the presence of seasonally migratory species to reinforce other, more concrete seasonal indicators.

Several roe deer frontal bones representing various stages in the yearly antler casting cycle are present. Multiple specimens each are present of uncast, casting, and recently cast roe deer skulls, indicating that the individual deer in question died at that stage of its life cycle. The recently cast antlers that have not yet started to regrow are strong indicators of a November and/or December date of death. The uncast antlers are less useful for seasonality determination, as the deer possess antlers for the majority of the year. Finally, antlers that are in the process of being cast further reinforce the strong November and/or December date of occupation.

Only modest numbers of young game animals are available, but several individuals under the age of one year provide some information as to their season of death. Five roe deer were determined to be under or around one year of age. The calcaneus of one individual was ca. three weeks old, indicated by the extremely porous nature of the bone and undeveloped epiphyseal ends. As roe deer are born from the end of May through early June, this indicates that this individual died in June (Richter and Noe-Nygaard 2003). Based on toothwear, the four other individuals are aged at four to five months, six months, six months, and one year of age. This places the time of death of these individuals between August and October, October to November, October to November, and late May to early June respectively.

Four wild boar individuals were aged. Wild boar were most likely born from mid-April to mid-May during the Mesolithic in Denmark (Noe-Nygaard and Richter 1990). Three individuals were aged at less than one year. One was six to twelve weeks of age, another was under 12 weeks old, and the last was between four and six months of age. This places their deaths between June and August, June and August, and August to November respectively.

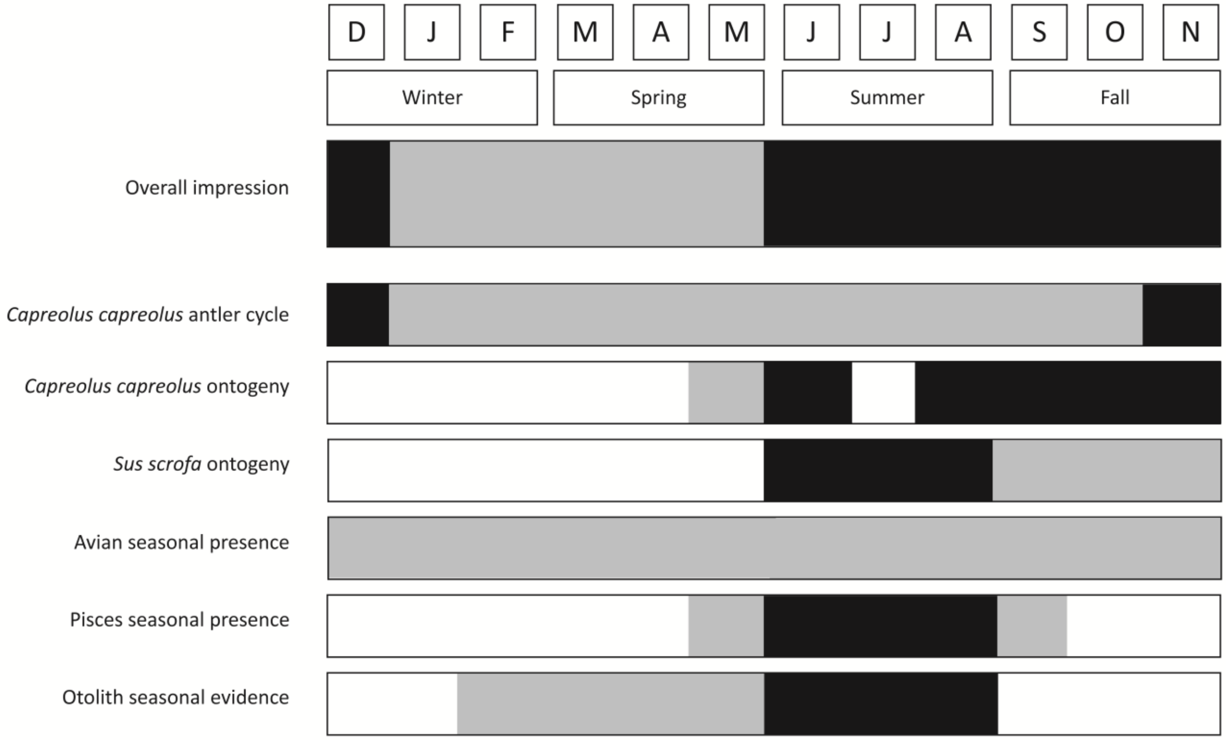


Figure 4.4:Cumulative seasonality data (darker colors indicate more confidence)

Figure 4.4 summarizes the seasonality information from animal remains for the site, including fish data presented earlier in this chapter (Ritchie et al., in review). Cumulative seasonality information indicates use during most, perhaps all, of the year. It is not possible to state whether this was the result of year-round occupation of the site, or instead, consisted of repeated visits in different seasons over the course of many years. It is, however, apparent that hunting and fishing took place at the same times of year, as evidenced by the co-occurrence of mammal and fish indicators in the annual cycle.

Body-Part Representation, Bone Modification, and Food Production

Burning, butchery, and tool production are all in evidence as means by which animal bones were modified by human activities. Less than 1% of the mammal material is affected by burning, indicating that most cooking occurred after removal of meat from the bones. Evidence of butchery (including sawing, cut marks, scrape marks) is present on some mammal bones, although the location of most of these marks is not further interpretable due to the highly fragmented nature of the material and the relatively low occurrence of these modifications. There were very few cutmarks observed among the material, with, for example, only 2.9% of the roe deer specimens, 2.8% of the wild boar specimens, and 1.6% of the red deer specimens exhibiting clear cutmarks.

Nearly all of the expected mammal bones, particularly those of the roe deer (36.4% of specimens), were fractured to gain access to marrow, but also those from both wild boar (16.3%) and red deer (27.9%). Evidence of this practice was provided by blow marks, cut marks, and scrape marks (Noe-Nygaard 1989). This is important to mention as it does not appear that differential overall representation in terms of relative abundance of red deer, roe deer, and wild boar is due to variable treatment of the bone. Bones from all three species were marrow fractured to extract marrow to similar extents. Examples of fracturing include larger skeletal elements, such as long bones, as well as smaller elements, including first and second phalanges which were snapped in half after a well-placed blow along the middle of the element. Because of the high dominance of roe deer, it was possible to ascertain how most bones were approached for fragmentation by Mesolithic hunters. In all, 4.4% of the roe deer specimens exhibited clear blow marks from a hammerstone (Noe-Nygaard 1989). In order to exhibit their locations, the blow marks were recorded on schematics of the deer long bones (Figure 4.5).

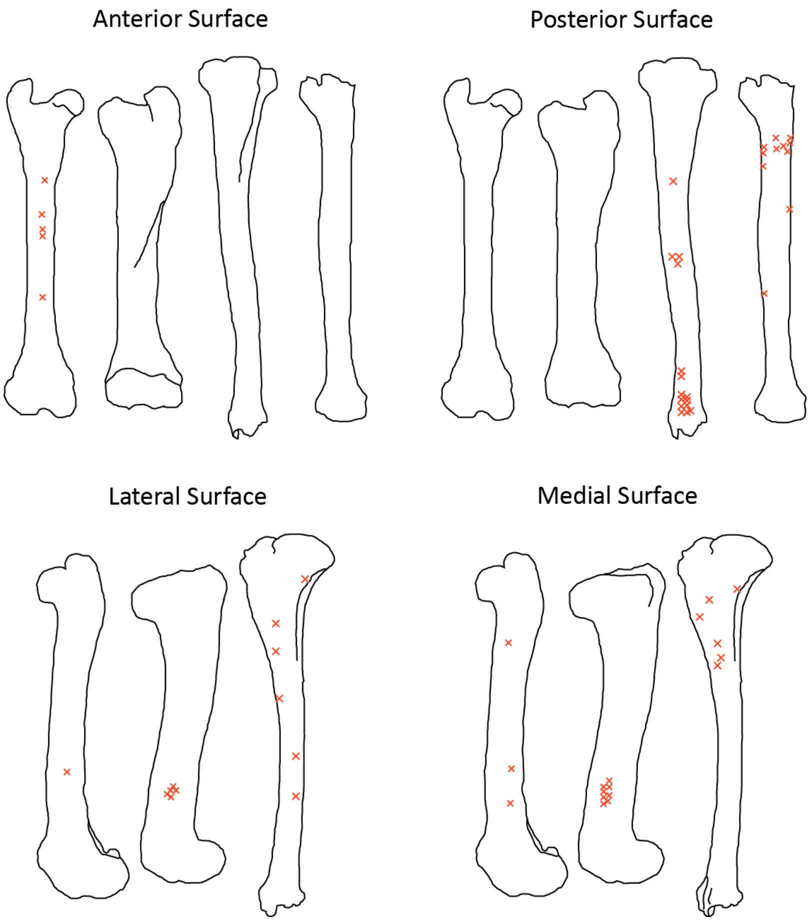


Figure 4.5: Locations of blowmarks on the bones of roe deer: collapsed data normalized for bilateral symmetry (left to right: femur, humerus, tibia, radius), lateral and medial aspects of the radius omitted for illustrative purposes due to the thinness of the bone

Although there is no clear process for breaking the bones evident from the recorded impact marks, some general observations can be made. Blows were placed to remove the articular surfaces, usually on the metaphyses, and then repeated blows were struck in order to access the marrow cavity. The only consistent locations for impact marks are found on humeri, where a lateral or medial blow near the distal end of the shaft was placed such that the bone could subsequently be twisted apart to access the marrow. Other than this, there does not appear to be any homogenous bone fracture pattern.

Considering the location of the site far out on a peninsula and the high frequency of roe deer in the terrestrial faunal material, it is important to establish whether individuals of this species exhibit any differential body-part representation which may indicate provisioning of the site from elsewhere. Calculated %MAU data are graphically depicted in Figure 4.6 (calculations shown in Table 9.2).

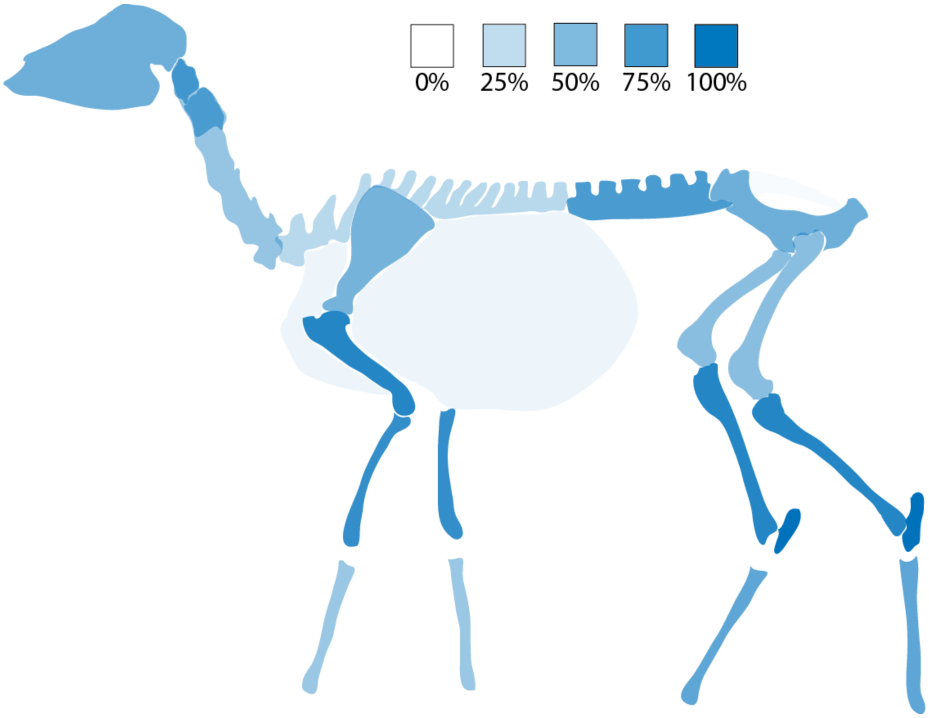


Figure 4.6: Percent MAU skeletal representation for roe deer

The relative abundances of specimens from each element in the skeletons of roe deer makes it clear that not all elements are equally well represented. However, there is no clear pattern that suggests only certain portions of the carcasses were brought to the site. This assertion is made only after comparison, and in full consideration of, other sites in the region addressed in this study, the results of which are addressed fully in Chapter 9. In any event, roe deer are most likely being butchered at the site, and therefore procured nearby. This assumes that a whole, unprocessed carcass would not have been carried to Asnæs Havnemark from any great distance which is a distinct possibility given its body size (Geist 1998), although the use of canoes for transport would render this conclusion moot. In any case, butchery data demonstrate that processing of roe deer was one of the activities that took place at the site.

Figure 4.7: Groove created by a stone tool in the mesial surface of a dextral dog tibia

In general, few bone specimens were worked or prepared for the manufacture of tools. However, one aspect particularly noteworthy is the degree and specificity of working traces found on bones of domestic dog. Nearly every identifiable specimen of dog long bone is worked in an almost identical way, with minor differences evident between types of bones. Such worked specimens usually consist of the end of the element, worked nearly up to the area of fusion at the epiphyseal end. Linear cuts are made on opposite sides of the bone, usually perpendicular to the flattest and straightest edge of the individual element in question (Figure 4.7). For example, considering the working pattern of distal tibiae, a groove is incised into the lateral and medial surfaces of the distal shaft of the bone providing an opportunity to separate and split the flat anterior and posterior surfaces of the bone, while cutting into the more rounded surfaces. Then, the segment of the long bone shaft was thinned to provide a uniform and flat surface (Figure 4.8).

Figure 4.8: Mesial aspect of a dextral dog tibia worked on a lateral-mesial plane

Because of these traces of working and subsequent treatment to perpendicularly snap the prepared flat surfaces (Figure 4.9), it is suggested that such working is for the manufacture of fishhooks. A minimum of 21 whole or partial bone fishhooks and at least 6 preforms were recovered during excavation.

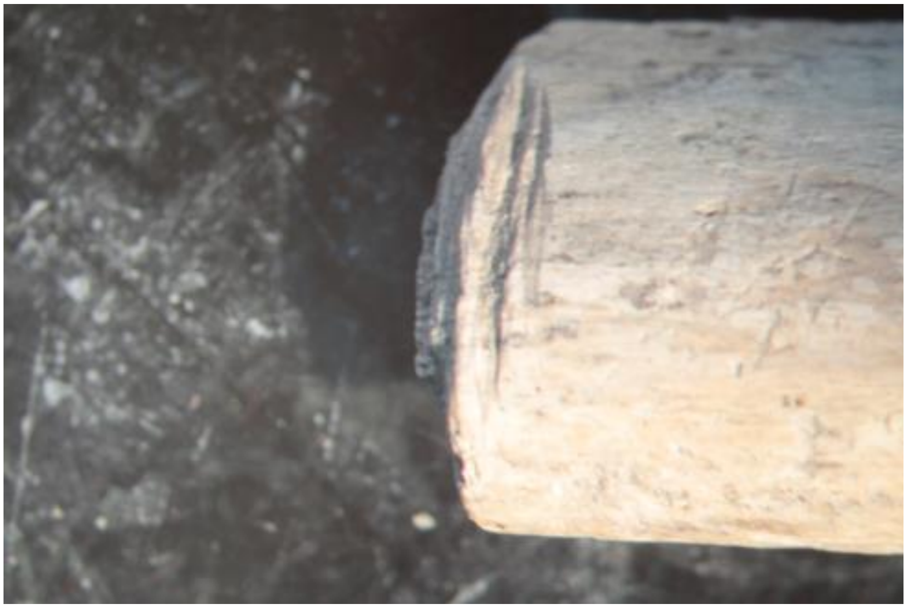


Figure 4.9: Magnified worked and snapped lateral shaft surface of a dextral dog tibia

In total, 119 specimens are attributable to dog, comprising 5.3% of the identified material. Of the dog bone material, 11 specimens (9.2%) show unequivocal evidence of working for tool manufacture. Elements showing evidence of working include radii, tibiae, femora, and humeri, and belong to at least two individuals (possibly three). Both fused and unfused proximal femora are present, indicating both adult and subadult dogs were worked. In contrast, roe deer make up 66.5% of the recovered sample, but less than one percent of the bones (10 specimens) shows definite or *possible* evidence of being worked in any way. None of the working traces are unequivocally for tool manufacture. However, 36.2% of the roe deer material (making up 24.1% of the entire sample from the site) shows clear evidence of fracturing to get marrow. No dog remains show evidence of such fracturing. Presumably, the size and density of comparable skeletal elements in roe deer and dogs are broadly similar. As such, they should have similar mechanical properties for the manufacture of tools. The high incidence of worked dog bones, coupled with the almost complete lack of evidence for the working of bones of similar-sized mammals, shows a clear preference in raw materials for tool manufacture. Ultimately, the reason for preferentially selecting dog bones for tools remains enigmatic.

Isotope Data

Results from carbon and nitrogen isotopic ratio analyses are presented in Table 4.3. All samples listed fall within acceptable range of atomic C:N ratios for bone preservation indicating a low likelihood of diagenesis (White et al. 2001). All wild animals show values that are within the normal ranges for southern Scandinavia (Fischer et al. 2007). Terrestrial roe deer show highly similar values, indicative of an herbivorous diet in a very similar environment. The wild boar specimen indicates slight enrichment relative to the deer, probably due to its omnivorous dietary preferences. The grey seal is highly enriched as expected for a marine carnivore. The dogs present isotope ratios that indicate they were eating an almost entirely marine diet similar to the single highly enriched dog found at nearby Smakkerup Huse (Price and Gebauer 2005). Further, the nitrogen values indicate at least one trophic level of enrichment compared to herbivores. Assuming that dogs are indeed a good proxy for human diet at Asnæs Havnemark, the two individuals analyzed here indicate that the people were subsisting almost entirely on marine protein. This does not necessarily mean that terrestrial resources were unimportant – the large amount of bone material from these types of animals proves that they had a role – but the dog isotope data underscores that marine resources were the staple foods in the longer-term diet.

Number	Species	Lab #	%C	%N	Atomic C:N	VPDB‰	AIR‰
AH24-49	*Capreolus capreolus*	258926	21.78	7.2	3.53	-22.99	4.76
AH40-19	*Capreolus capreolus*	268260	16.41	5.24	3.66	-22.94	5.47
AH74-15	*Capreolus capreolus*	268261	18.45	5.82	3.70	-23.07	5.90
AH70-14	*Capreolus capreolus*	268262	20.07	6.58	3.56	-22.81	5.80
AH73-16	*Sus scrofa*	268266	17.24	5.74	3.50	-20.90	5.18
AH84-1	*Sus scrofa*	284462	35.46	12.70	3.26	-20.86	5.41
AH70-20	*Halichoerus/Phoca* sp.	268269	18.88	6.37	3.46	-9.58	14.20
AH85-4	*Canis familiaris*	268272	15.06	4.88	3.60	-11.94	10.13
AH83-10	*Canis familiaris*	268273	14.30	4.60	3.63	-13.24	11.87

Table 4.3:Stable isotopic ratios of carbon and nitrogen

Discussion

The site location, faunal assemblage, and tool technology all point to the conclusion that the people who lived at Asnæs Havnemark oriented their lives towards the sea. Isotopic evidence indicates that seafood was the most important part of the diet although the relative contribution of marine versus terrestrial foods is not completely clear. The overall impression of animal use at the site is one of both focus and breadth. In this sense, the diet of the inhabitants appears to be similar to the pattern known from many other Ertebølle sites. While the assemblage is strongly dominated by fish of the cod family and roe deer, there is a wide range of other species present.

Seasonality evidence, when taken in aggregate indicate occupation over much, if not all of the year. Newly shed antlers and aged specimens of roe deer place time of death almost continuously between the summer and early winter, while wild boar were killed most likely in the summertime. Birds offer less concrete evidence of seasonality. Isotopic studies of otolithis from cod, and the seasonal presence of certain species of fish also indicate summer occupation, but also indicate that fishing may have taken place over much of the year. There is no clear pattern of age distribution of killed animals, aside from the fact that ageable specimens of all taxa appear to show no particular focus on a single age group. However, there might be a slight bias towards younger roe deer within the assessable sample.

The mammal assemblage is dominated by the roe deer (ca. 2/3 of the identified fauna). The reasons for their abundance are less than clear. These animals were probably killed on the peninsula and not butchered elsewhere to be selectively transported to it (Chapter 9). This assessment is supported by the relative ubiquity of various skeletal elements and also by the rather tight distribution of isotopic values which likely indicate that these roe deer lived in extremely similar, if not the same habitat. This is not to say that the possibility of transport of whole carcasses by boat to the site can entirely be excluded.

Further, nearly all suitable faunal material is fractured for marrow, but the placement of blow marks does not show a clear pattern of application. Despite their ubiquity, roe deer do not appear to have been used for the manufacture of fishhooks, with dog remains specifically selected for such activities. This is the most enigmatic aspect of the finds, as there is no conclusive reason for this preference given the huge number of roe deer remains.

Based on their high relative abundance, roe deer were the most important terrestrial game. In terms of size, however, even assuming a deliberate and very generous underestimate of the ratio of overall body weight between a roe deer and a red deer (using values from Geist 1998), an adult red deer is at least four times heavier than a roe deer, indicating that the MNI values for roe deer (MNI=19) and red deer (MNI=3) are not that dissimilar in terms of meat content. The conclusion is that while they dominate the assemblage, roe deer were not necessarily the most important species in terms of subsistence.

The location of the site on this peninsula likely explains the presence of species that are not as common on Ertebølle sites. Seals, in particular, generally prefer secluded locations when they haul out (Riedman 1990). Such localities may include islands or other isolated areas such as the end of long coastal peninsulas. The seal remains may be the result of clubbing seals while on land at a haul out location near the site although hunting with harpoons from boats probably occurred as well. Of particular note are the number of seal remains and extensive cutmarks on some specimens (12.7%) which indicate the utility of the seal to the hunters at the site. Overall, this seal assemblage is broadly similar to that from Ølby Lyng in terms of relative abundance of seals. Their presence at Ølby Lyng was interpreted to have been at least in part a deciding factor in the location of the site (Møhl 1971), and the same is probably true for Asnæs Havnemark.

In addition, the location may also explain the rather lower numbers of red deer at the site relative to other Ertebølle sites in the region (Enghoff 2011; Gotfredsen 1998; Møhl 1971; Noe-Nygaard 1995; Price and Gebauer 2005; Skaarup 1973), as limited land area may have restricted the numbers of such a large animal (Geist 1998; Kamler et al. 2008). The location would have less affected the abundance of the much smaller roe deer, a species that often lives at higher population densities than red deer (see reviews in Kamler et al. 2008; Gill et al. 1996). In fact, aside from the large representation of roe deer, one of the most notable aspects of this assemblage is the markedly depressed occurrence of red deer. There are proportionally fewer red deer found at this site than in Ertebølle assemblages from elsewhere on Zealand.

Fur animals were found in numbers that indicate they were of considerable use to the site’s occupants. With at least five individuals of pine marten represented, obtaining these animals must be considered an economic activity. The purpose of taking these species was to obtain a valuable resource for the cold winter months, a probability reinforced by finds of pine marten in appreciable numbers at other Ertebølle sites in Denmark.

Birds appear to have been taken *ad libitum* as they are sparsely represented. Two general types of birds were taken, waterfowl and raptors, probably by hunting strategies specific to the class desired by the Ertebølle hunters. Probably hunted either with nets or with bow-and-arrow, acquiring various types of birds required using specific skills and equipment such as birding arrows that have been found at other Ertebølle sites (Andersen 1985), than would have been required for hunting other game. Birds were taken for food as well as possibly to obtain raw materials - feathers for fletching, and bone for other uses (e.g., decoration, fishhooks, bone awls/points). The large number of species is indicative of a lack of a clear interspecific focus on birding at the site.

Fishing at the site was clearly a major, if not the dominant subsistence activity. The extremely large fish sample is utterly dominated by codfish (Gadidae) and eel (Anguillidae) to a much lesser extent, although a substantial number of types were recovered. The manufacture of fishhooks at the site points strongly to angling, while other fish may also have been taken using nets (Ritchie et al., in review).

Particular skills and procurement strategies are required to obtain terrestrial game, fur animals, seals, raptors, waterfowl, and the various species of fish. The wide variety of animals represented in the Asnæs Havnemark assemblage indicates that the people who lived there were proficient in a number of hunting and fishing techniques. The predominance of roe deer in the mammal material and cod in the fish material does indicate a distinct degree of economic specialization, but perhaps more of a *de facto* variety based on the unique set of circumstances accompanying the site's location. However, it is important to remember that the inhabitants of Asnæs Havnemark were not so much constrained by the availability of animals in the vicinity of the site, as drawn there because of the prey that was present.

Conclusions

Asnæs Havnemark was a hunting and fishing site for codfish, roe deer, eel, fur animals, seals, and birds, and was probably visited over much of the year. This is not to imply that people were resident at the site however, as repeated visits in different seasons cannot be ruled out. Many species requiring specific hunting strategies and skills were obtained, indicating a high degree of flexibility in hunting activities among the EBK groups utilizing the site. The assemblage is of particular note given its extremely high numbers of fish bones, as well as the dominance of roe deer in the faunal assemblage. In all, the site is notable not only for the dominance of particular species, but also for the richness of the resources obtained. Finally, the working of dog bone for fishhook manufacture is the first instance of its kind yet found in the Danish Ertebølle.

Chapter 5: Fårevejle

Introduction

Fårevejle is included here as an example of an Ertebølle kitchen midden from northwest Zealand. The site was originally located along the sheltered inland-side northwest coast of the now dry-land Lammefjord (T.D.Price unpublished data). The midden was first excavated by the Second Kitchen Midden Commission, and data from those excavations were published by Madsen et al. (1900). In contrast to the other reported sites in this study, as a shell midden, Fårevejle potentially may have had a different purpose than its counterparts, and seasonality data indicate seasonal, periodic occupation. This site is of interest given its status as a shell midden, as in contrast to Jutland, as very few of this type of site have been excavated on Zealand (Enghoff 2011; Madsen et al. 1900; Skaarup 1973). Ultimately, with data that indicate seasonal, periodic occupation, the site can be interpreted as a late winter and spring hunting camp for the big three, a location for the procurement of mollusks, a fishing locality for members of the cod and flatfish families, and a minor locality for fox trapping or hunting.

Previous Investigations

Madsen et al. (1900) reported water vole, domestic cow, domestic dog, roe deer, beaver, red deer, wildcat, European otter, pine marten, wild and/or domestic pig, and fox at Fårevejle. Birds listed as present were the long-tailed duck (*Clangula hyemalis*) and the herring gull (Madsen et al. 1900). Four species were reported that were not encountered again in the current investigation, beaver, domestic cattle, the long-tailed duck and the herring gull. However, because sample sizes were extremely small, and most taxa were represented by only a few specimens, this is not a surprising result. In need of special mention are the domestic cattle, represented by several teeth. However, due to the presence of some Middle Neolithic material at Fårevejle, and due to a lack of discussion in Madsen et al. (1900) of where the cattle teeth were found stratigraphically, it would be unwise to further interpret these finds.

The Bone Material

In total, 14,343 bones (excluding fish) were recovered from excavations at Fårevejle. Of those, 8.93 % (1,281) are identifiable to species or class of species (Table 5.1). Of the identifiable bone, the vast majority (1,268) is mammalian, making up 99.0% of the identifiable sample. The remaining 1% of the identified material are birds, in total only 13 bone specimens.

At a minimum, 12 species of mammal are presumed present, but not all of these species can be listed. For example, seals are present, although the exact species was not determinable owing to the difficulty with which seal species are differentiated from one-another. In this case, at least one species is present, but the possibility that more than one taxon may be represented cannot be ruled out. The same is true with the non-specific ovicaprid remains. Diagnostic elements are not present, and, therefore, the larger, lumped category is used. Again, as with the seals, at least either goat or sheep are present, and the possibility that both were found cannot be excluded as there are two specimens.

Taxon	NISP	MNI
Sus scrofa	554	6
Capreolus capreolus	435	8
Cervus elaphus	231	5
Vulpes vulpes	26	2
Felis silvestris	7	1
Seal unspecified	5	1
Lutra lutra	3	1
Capra/Ovis	2	1
Arvicola terrestris	2	1
Canis familiaris	1	1
Martes martes	1	1
Apodemus flavicollis	1	1
total	**1268**	
Cygnus sp.	3	1
Anas sp.	3	1
Alca torda	3	1
Uria aalge	2	1
Mergus merganser	1	1
Mergus serrator	1	1
total	**13**	

Table 5.1: Relative abundance data

As for the burrowing smaller mammals, the water vole and yellow-necked mouse are often not archaeological (Aaris-Sørensen and Andreasen 1992), and due to their low representation and complete lack of evidence of their use by man, are not considered to be so. While rare,fur mammals are the only other class of mammal present. These mammals include the fox, wildcat, European otter, and pine marten, and comprise only 2.9% of the mammal sample. Of these, the best represented species is the fox, which makes up 2.1% of the mammal sample. The majority of the mammal sample (96.2%) are wild boar, roe deer, and red deer, as is typical for Ertebølle sites. Domesticated animals are represented by the domestic dog and ovicaprids. Excluding the water vole and the yellow-necked mouse, the total number of mammal taxa related to human activity can be considered to be, at a minimum, 10.

At least 6 species of birds are present at Fårevejle and comprise only around 1% of the entire identifiable assemblage. Two of the bird species are represented only by class, as they were not determinable more specifically. The swan genus *Cygnus* is represented, although it was not possible to determine which species is represented. The possibility cannot be ruled out that that the sample may comprise more than one. The duck genus *Anas* is found, although of the number of species in the genus, the exact one could not be determined. As three specimens were present, the unlikely possibility cannot be excluded that up to at least three species of duck may be represented. Four other birds were determinable to specific level; razorbill (*Alca torda*), common mure (*Uria aalge*), goosander (*Mergus merganser*) and red-breasted merganser. All were represented by only a few specimens. At a minimum, the number of bird taxa can be considered to be 6.

Fish

Fish bones from Fårevejle were analyzed by Ritchie (2010). The numbers of fish bones are modest, but the 2,783 specimens identified comprised fourteen types of fish from twelve families (Ritchie 2010). In all, members of the cod family (Gadidae) are predominant (57.7%) with flatfish also very common (38.1%) (Ritchie 2010). Fishing of Gadidae indicates, “cool season occupation” (Ritchie 2010:

166), but as Scombridae and Belonidae are scarce, summer indicators in the fish assemblage are weak (Ritchie 2010).

Preservation

In general, the material from Fårevejle is poorly preserved. The bone material is a light sand hue. It is highly fragmented (see quantification below). The bone is brittle, and in many cases starting to degrade at the surface. As the bone is quite fragile, its brittleness has undoubtedly exacerbated fragmentation during storage. The bone is light unlike fresh bone which may indicate that there is little/no preserved collagen. The degree of overall fragmentation, however, is extremely similar to that at Havnø (see Chapter 7). The bone surface is often obscured or flaked away, so the observed absence of surface marks may not be due to true absence. In general, there are no surface obstructions, however, and, where preserved, the actual surface of the bone is visible.

Preservation is mostly uniform, as is typical among material from shell middens. However, there is somevariation in degree of weathering and preservation. The material falls most completely into Behrensmeyer's (1978) Category 3 as the compact bones are rough, homogeneously weathered and have a fibrous texture. Weathering does not penetrate more than one to one and a half millimeters and only rarely through the outer surface of the bone. Additionally, the material most often falls into Noe-Nygaard's (1995) Category 4, as surface characteristics are not traceable, and multilayered exfoliation of the outer surface is common.

Fragmentation

The bones from Fårevejle are highly fragmented, as is to be expected for material from a kitchen midden (See comparisons with Havnø in Chapters 9 and 10). Nearly all of the bones are under a maximum length of five centimeters, with 40.8% of all bones between one and two centimeters in maximum length (Figure 5.1). In conjunction with the taphonomic discussion, the quantified fragmentation underscores the highly comminuted nature of the faunal assemblage.

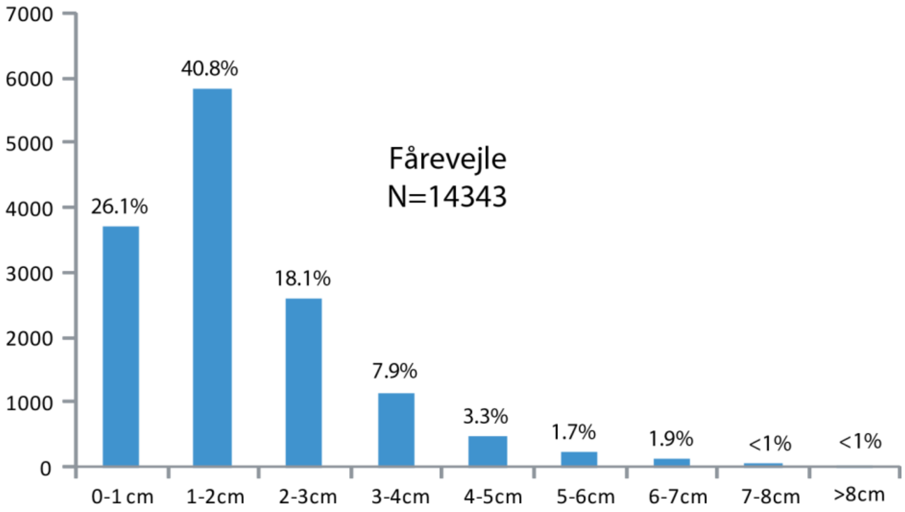


Figure 5.1: Maximum length of all bones recovered

Species Representation By Level

In order to assess change through time in the abundance of terrestrial mammal species, relative abundance (quantified by NISP) was assessed by layer within the midden. This was only done for Unit 1 (see Figure 5.2), as Unit 2 and Unit 3 neither yielded extensive material nor contained all levels present in the much larger Unit 1.

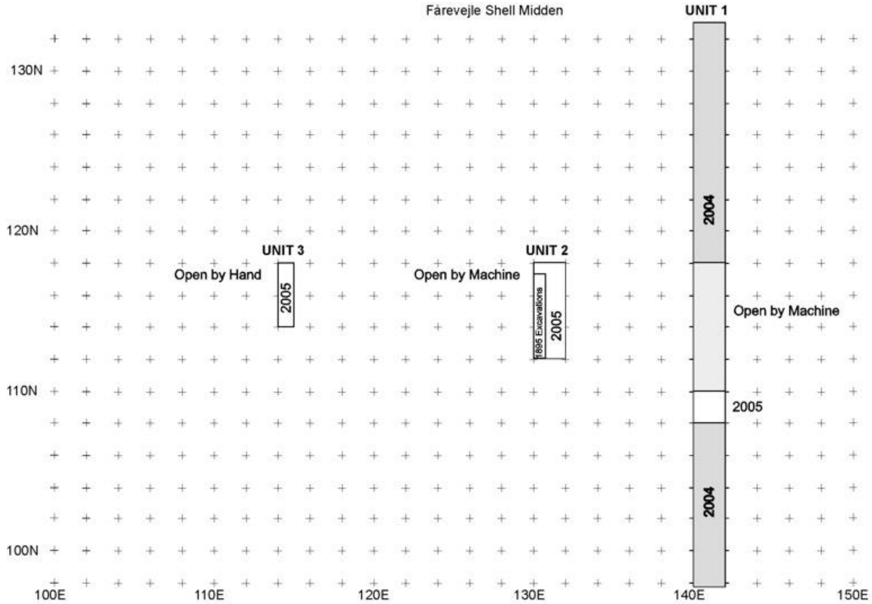
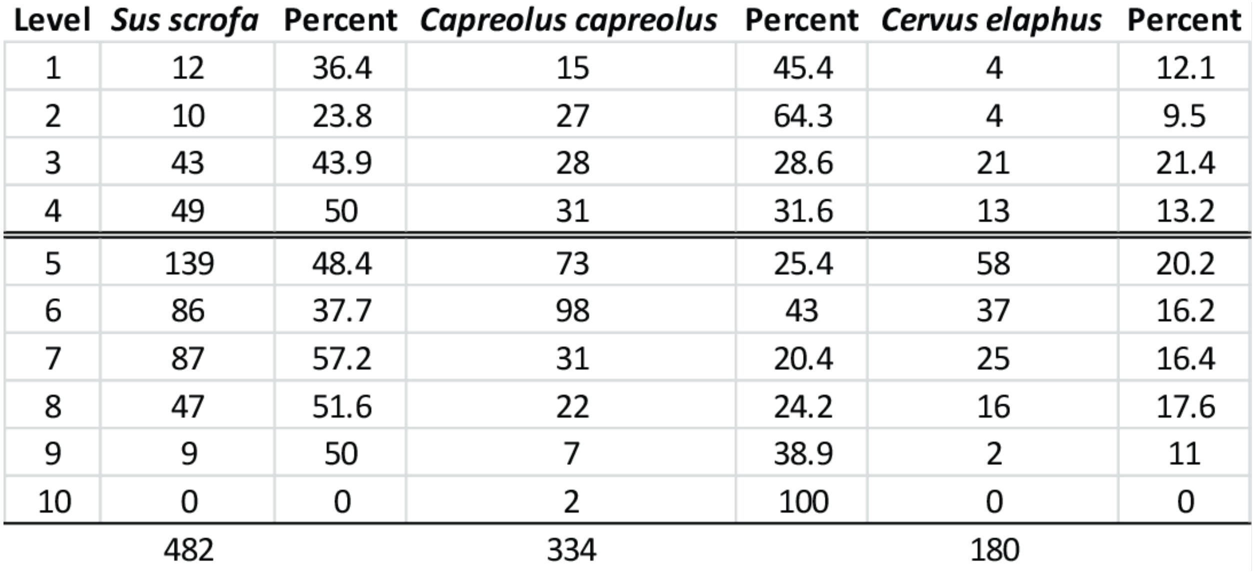


Figure 5.2: Plan of Fårevejle excavations

In general, the only species of sufficient number which can be discussed in terms of changing or relative abundance are the typically most common red deer, roe deer, and wild boar. These three species make up 95.2% of the determinable specimens from the site. Representation by level of Unit 1 is shown in Table 5.2, and the relative abundance of these taxa is shown in Figure 5.3. The stratigraphy at Fårevejle is complicated, so interpretations here are made to be general, and not necessarily a precise determination in the importance of these three species over the development of the midden. In addition, Levels 1-4 are probably Neolithic. Regardless, the majority of the material from the site is attributable to the EBK (Table 5.2).



Level	*Sus scrofa*	Percent	*Capreolus capreolus*	Percent	*Cervus elaphus*	Percent
1	12	36.4	15	45.4	4	12.1
2	10	23.8	27	64.3	4	9.5
3	43	43.9	28	28.6	21	21.4
4	49	50	31	31.6	13	13.2
5	139	48.4	73	25.4	58	20.2
6	86	37.7	98	43	37	16.2
7	87	57.2	31	20.4	25	16.4
8	47	51.6	22	24.2	16	17.6
9	9	50	7	38.9	2	11
10	0	0	2	100	0	0
	482		334		180	

Table 5.2: Unit 1 wild boar, roe deer, and red deer representation by level (NISP, double line indicates the Mesolithic-Neolithic divide at the site, older at bottom)

Throughout the history of occupation, red deer are always the least important of the three. The abundance of wild boar and roe deer is an inverse relationship, that is, as wild boar become better represented, roe deer become less so. However, both always remain more common than red deer. While the abundance of these species relative to one-another shows this pattern, this is not to be taken as a constant degree of use of these species over the history of the midden's accumulation. The most concentrated representation of these species, as demonstrated by the highest numbers of their bones deposited, occurred in the middle layers, particularly Levels 5, 6, and 7, all attributable to the EBK. These layers may indicate the periods of the most intensive hunting activities at the site.

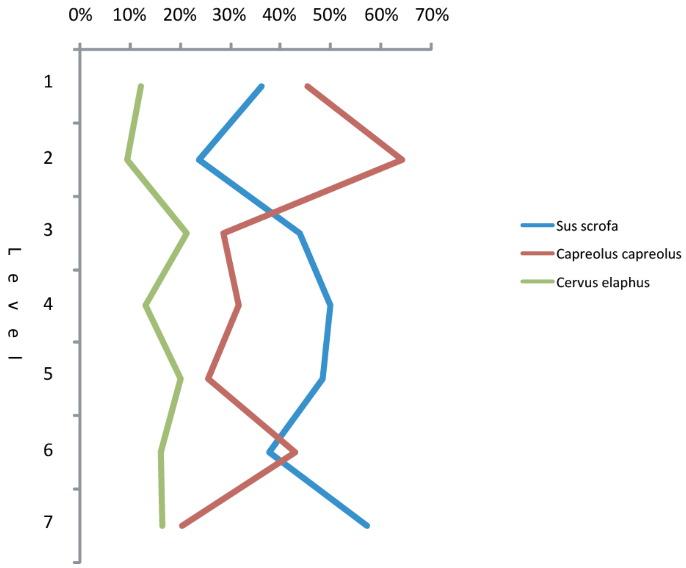
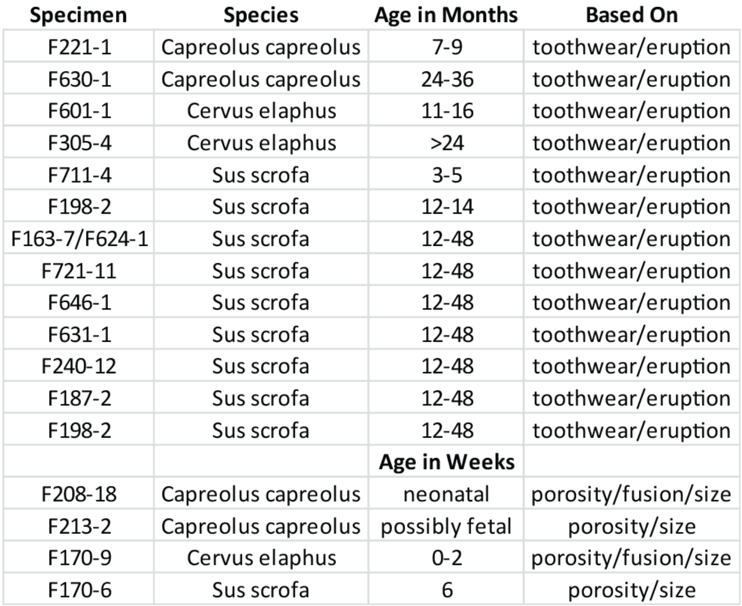


Figure 5.3: Representation through time (NISP, oldest at bottom)

Ultimately, the picture is rather constant in terms of the abundance of these three species at the site relative to one another, in that there is a build-up in intensity of hunting and then a tapering-off. While unsurprising, the abundance of these species over time indicate that red deer near to the site may have been a relatively limited resource relative to elsewhere, and only utilized as a secondary resource to roe deer and wild boar, regardless of the intensity of hunting activities. Simply, there may not have been many local resident red deer.

Age Structure of the Finds

Only 13 specimens were ageable using toothwear and eruption, including only two roe deer specimens (F221-1, F630-1), two red deer specimens (F601-1, F305-4) , and nine wild boar (F711-4, F198-2, F163-7/F624-1, F721-11, F646-1, F631-1, F240-12, F187-2). Ages are seen in Table 5.3.



Specimen	Species	Age in Months	Based On
F221-1	Capreolus capreolus	7-9	toothwear/eruption
F630-1	Capreolus capreolus	24-36	toothwear/eruption
F601-1	Cervus elaphus	11-16	toothwear/eruption
F305-4	Cervus elaphus	>24	toothwear/eruption
F711-4	Sus scrofa	3-5	toothwear/eruption
F198-2	Sus scrofa	12-14	toothwear/eruption
F163-7/F624-1	Sus scrofa	12-48	toothwear/eruption
F721-11	Sus scrofa	12-48	toothwear/eruption
F646-1	Sus scrofa	12-48	toothwear/eruption
F631-1	Sus scrofa	12-48	toothwear/eruption
F240-12	Sus scrofa	12-48	toothwear/eruption
F187-2	Sus scrofa	12-48	toothwear/eruption
F198-2	Sus scrofa	12-48	toothwear/eruption
		Age in Weeks	
F208-18	Capreolus capreolus	neonatal	porosity/fusion/size
F213-2	Capreolus capreolus	possibly fetal	porosity/size
F170-9	Cervus elaphus	0-2	porosity/fusion/size
F170-6	Sus scrofa	6	porosity/size

Table 5.3: Ages of specimens

Several other specimens were ageable based on morphological characteristics, such as epiphyseal fusion, bone porosity, and size. Only several of these were reliably attributable and exhibit at a minimum several of the indicators. In general, simple epiphyseal fusion was not used to age individuals, as oftentimes fusion occurs after a year of life (Noe-Nygaard 1987), negating the usefulness of such information alone for determination of seasonality of death. However, for the purposes of discussion in this case, otherwise aged animals take epiphyseal fusion into account but only in conjunction with other age-indicating traits and in particular, using comparative material of known age.

In all, 186 of 1281 specimens (14.5%) determined to species were classified as juvenile or neonatal. There are four notable instances which combined several of these criteria and are, therefore considered to be reliably aged. These include one red deer (F170-9), one wild boar (F170-6), and two roe deer specimens (F208-18, F213-2). Of particular note are the two roe deer specimens, which represent a fetal and a newborn individual (Figure 5.4). Ages determined in this fashion are seen in Table 5.3.

Finally, while not accurately ageable due to being loose teeth, several specimens could only have come only from extremely old individuals based on their molars having been worn nearly flat (for example F74-4, F64-3, and F627-1). These specimens come from the big three, and indicate that very old individuals from the three main species also can be considered to have been present.

Figure 5.4: Roe deer neonatal (F208-18, left) and possibly fetal (F213-2, right) right humeri

Season of Occupation

Indicators of season of occupation are limited at Fårevejle, limited by the material. A summary of evidence for seasonal occupation at Fårevejle can be seen in Figure 5.5. The strongest indicators of seasonality at the midden are the three newborn or young juvenile specimens described in the previous discussion (see Table 5.3) of red deer (F170-9), wild boar (F170-6), and roe deer (F208-18, F213-2). The death of the newborn red deer specimen (F170-9) occurred in May or June as both red and roe deer are born at this time of the year (Richter and Noe-Nygaard 2003). Similarly, the newborn roe deer specimen (F208-18) likely died in May or June (Figures 5.4 and 5.5). The identification of this specimen as newborn was based on size, porosity, and side-by-side comparisons with Ertebølle newborn roe deer specimens from Agernæs, Denmark (Richter and Noe-Nygaard 2003). Ultimately, both deer specimens show occupation in late spring or early summer at Fårevejle.

Figure 5.5: Cumulative seasonality data (darker colors indicate confidence)

Figure 5.6: Roe deer right humeri (from left: modern adult, neonatal, fetal)

Several other of the aged specimens can clarify the picture of seasonal occupation at the midden. One roe deer specimen (F221-1) was aged using comparative material to between seven and nine months of age, placing death sometime between December and March. Further, as Danish wild boar likely gave birth between the middle of April and the middle of May (Noe-Nygaard and Richter 1990), the six week old wild boar specimen (F170-6) and the two to five month old specimen (F711-4) place time of death sometime between July and October. Unfortunately, the fetal roe deer specimen (F213-2, Figures 5.4 and 5.6) cannot be used for seasonal assessment as sufficient literature and comparative material is not available. It was unborn at death, and it is unclear how far developmentally this specimen was from birth.

Four species of bird are present, only three of which can lend some insight into seasonality (Figure 5.5). Goosander, common murre (*Uria aalge*) and razorbill are all found in Denmark generally starting in the fall until the early spring (Génsbøl 2006). However, red-breasted mergansers are year-round visitors to Denmark and, therefore, are not useful for seasonal determination (Génsbøl 2006). As all three other species can be found in Denmark for large parts of the year, and due to the fact that they are all represented poorly by only several specimens, these are only considered ancillary indicators of season of occupation. Finally, some evidence of seasonality from fish remains comes from Ritchie (2010), as discussed above. The predominance of Gadidae in the assemblage points to cool season occupation, and the scarcity of Scombridae and Belonidae indicate a lack of evidence for summer occupation (Ritchie 2010).

In all, based on evidence from the current analysis, occupation can only be firmly placed between April and June, in the late spring and early summer. Redundant, yet less reliable indicators place occupation or offer some evidence or at least suggest the possibility of occupation for the rest of the year. Fish remains generally reinforce this view, as true summer indicators are scant within the bird and mammal data. Given that Fårevejle is an oyster shell midden, and the potential for the use of oysters as a stopgap winter and spring resource (Rowley-Conwy 1984, Milner 2002), year-round visits cannot be excluded from consideration. In all, the most likely interpretation of the seasonal information is seasonal visits to the site, mostly in the late winter and early spring, making the location a seasonal extraction site.

Body-Part Representation

Over 90% of the faunal material recovered from the midden was of three species, red deer, roe deer, and wild boar. Therefore, these three species are the best evidence available for an assessment of body-part representation at the site. Their larger numbers are most likely to exhibit differential body-part representation if present. Displayed in Figure 5.7 are %MAU diagrams for the deer from the site (calculations shown in Table 9.2). Small elements such as carpals, smaller tarsals, and phalanges are omitted because of their size for illustrative purposes, as well as for their presumed association with larger skeletal elements and unlikely separate processing with those elements. In all, the three main wild-game species show similar patterns of skeletal element representation. Elements of the axial skeleton, in particular the thoracic vertebrae, costae, and lumbar vertebrae are all rare in the assemblage. Long bones are similarly represented to one-another within each taxon, as are elements of the cranium, and mandible. Within each taxon, the upper limbs are best represented, followed by the head and mandible.

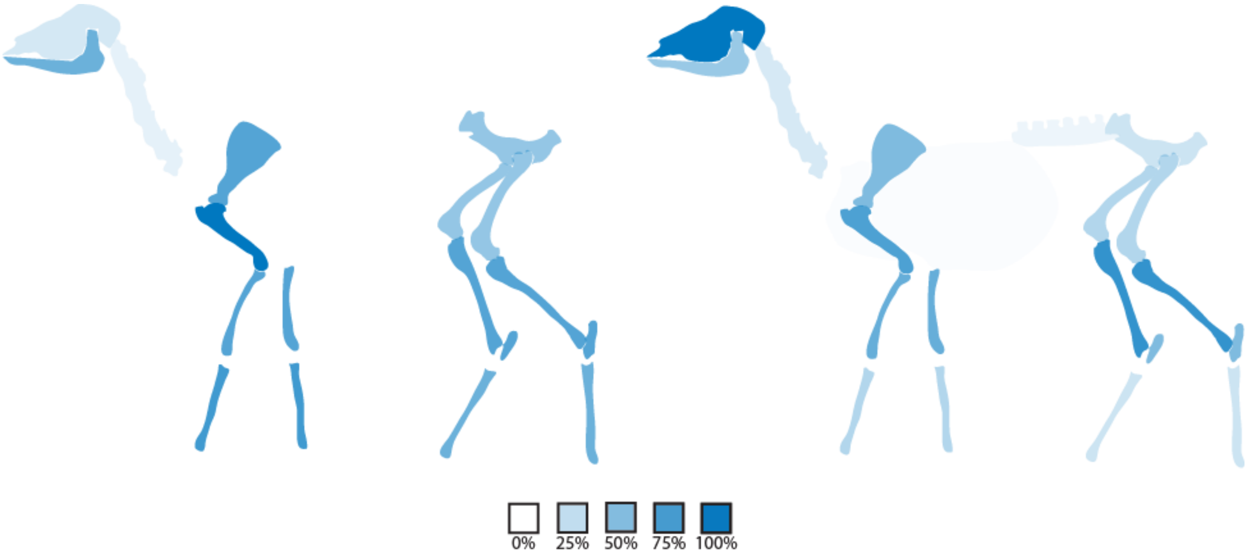


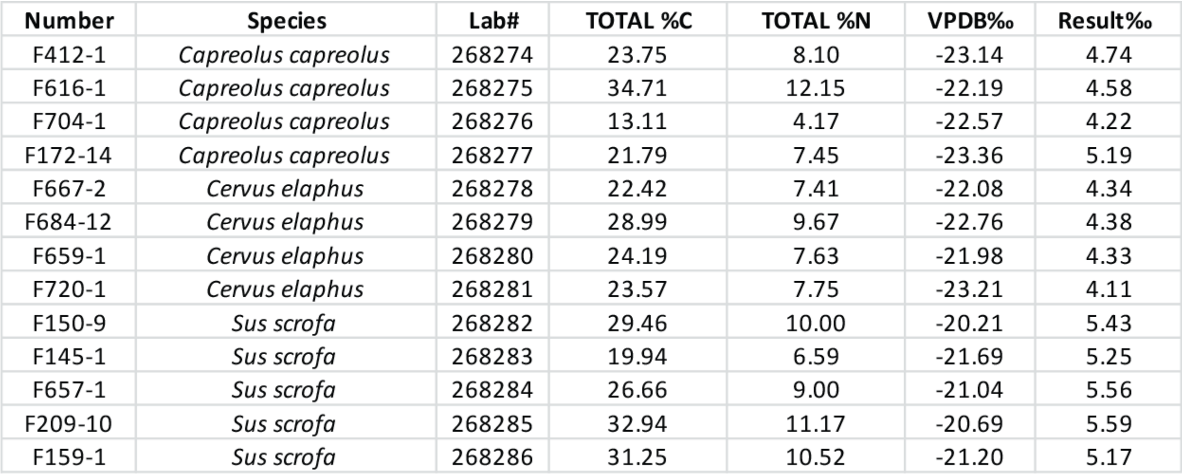
Figure 5.7: Percent MAU skeletal representation for roe deer (L) and red deer (R)

This pattern is consistent with density-mediated skeletal attrition, in which more robust elements are better preserved than less-dense or more fragile elements due to destructive taphonomic processes after deposition (see Chapter 9 for further specific discussion). In consideration of such density (Lyman 1993), limb, foot, and head elements show similar, more robust bone densities, with the axial skeleton less dense, and correspondingly less robust within the archaeological record. A further, more in-depth discussion of this correlation is included later in this work (Chapter 9).

Percent MAU for individual elements closely approximates density values for these body zones, with the axial skeletal elements rarer because they are less dense (Lyman 1993; Chapter 9). Appendicular elements are more common. It is for this reason that it is likely that carcasses of these three species were hunted nearby, brought whole to the site, and butchered there. The only other explanation for the observed pattern would be preferential transport of the head, fore-, and hindlimbs of all species to the site. This is an unlikely situation given that the transport requirements of all three taxa are quite different given variation in body size. While it is not necessary to butcher a small roe deer prior to transport, it may be required for a red deer, unless a boat or sledge is available for use, depending on the season. In other words, EBK hunters were likely coming to the location of the midden at Fårevejle and procuring at least these three wild resources nearby and butchering them there.

Isotope Data

Thirteen samples from wild animals recovered from the shell midden were submitted for carbon and nitrogen isotopic ratio analyses (Figure 5.8). Three species were analyzed; four samples of roe deer, four samples of red deer, and five samples wild boar representing distinct individuals were tested. Average carbon and nitrogen values for roe deer were -22.82‰ and 4.68‰. For red deer the values were -22.51‰ 4.29‰ and for wild boar the values were between -20.97‰ and 5.41‰. In all, the terrestrial species are well within the range for similar samples from the region (Fisher et al. 2007). On average, roe deer and red deer were browsing in very similar environments and on similar food sources, as they show similar enrichment in both carbon and nitrogen. Wild boar shows more enrichment than the terrestrial herbivores in all likelihood due to its omnivorous tendencies, a fact underscored by enrichment in both carbon and nitrogen isotopic ratios (Genov 1981). In conjunction with other data from the site, isotopic data from Fårevejle indicate that all species were likely hunted in similar environments, possibly near to one-another and probably near to the midden itself.



Number	Species	Lab#	TOTAL %C	TOTAL %N	VPDB‰	Result‰
F412-1	*Capreolus capreolus*	268274	23.75	8.10	-23.14	4.74
F616-1	*Capreolus capreolus*	268275	34.71	12.15	-22.19	4.58
F704-1	*Capreolus capreolus*	268276	13.11	4.17	-22.57	4.22
F172-14	*Capreolus capreolus*	268277	21.79	7.45	-23.36	5.19
F667-2	*Cervus elaphus*	268278	22.42	7.41	-22.08	4.34
F684-12	*Cervus elaphus*	268279	28.99	9.67	-22.76	4.38
F659-1	*Cervus elaphus*	268280	24.19	7.63	-21.98	4.33
F720-1	*Cervus elaphus*	268281	23.57	7.75	-23.21	4.11
F150-9	*Sus scrofa*	268282	29.46	10.00	-20.21	5.43
F145-1	*Sus scrofa*	268283	19.94	6.59	-21.69	5.25
F657-1	*Sus scrofa*	268284	26.66	9.00	-21.04	5.56
F209-10	*Sus scrofa*	268285	32.94	11.17	-20.69	5.59
F159-1	*Sus scrofa*	268286	31.25	10.52	-21.20	5.17

Table 5.4: Stable isotopic ratios of carbon and nitrogen

Discussion

The general picture of the bone material from Fårevejle is that of an assemblage dominated by the typical EBK terrestrial fauna; red deer, roe deer, and wild boar, with any use of fur animals only minor. Importantly however, this is a shell midden, and, therefore, while other game was probably of low importance, mollusks were undoubtedly a very important part of the economy at the site. Also, given the fish remains recovered, cod and flatfish procurement was also a major part of the economy (Ritchie 2010). Concerning the terrestrial mammals at the site, it is clear that hunting of the big three was absolutely the focus of terrestrial hunting activities at the site, with trapping of fur, particularly foxes an activity performed *ad libitum*.

The presence of seals is demonstrated. Domestic ovicaprids are present, although again, their presence is considered unrelated to the Stone-Age economy of the site due to their low representation as well as presence only in Level 1, the uppermost stratigraphic layer of the midden. These specimens are most likely not Mesolithic. Avian remains are all of waterfowl, and their presence can only be used to add weight to seasonal interpretations, as their numbers surely could not have contributed in any large degree to the economy of Fårevejle. Among the best represented species (red deer, roe deer, and wild boar), there appears to be no clear pattern of use of a specific age of animal. A number of ages, from newborn to very old are represented, indicating either a lack of a focused hunting of a specific age class, or a lack of population stress among the hunted populations. Based on the differential body-part representation profiles of these three species, the best explanation is that all three of these game species were being hunted near to the site, and transported whole or nearly whole to the site, where they were butchered. Unfortunately, the highly fragmentary nature and rather poor preservation of the assemblage precludes any further quantification of butchery, as the surface of the bone is often obscured, and degree of fragmentation makes reconstruction of reduction impossible.

Seasonality evidence, based on the ontogenetic ageing of specimens found at the site, migratory birds, and the best times of the year to procure oysters is strong, and most likely indicates visits in the late spring and early summer. Although the possibility cannot be excluded of potential year-round visits, considering the potential stopgap use of oysters in the winter and spring months (Milner 2002), the most likely situation is one of highly seasonal visits to the site. Domesticates are rare, and owing to the presence of at least several middle Neolithic dates and reinforced by their find locations falling in the upper layers of the midden, likely are not Ertebølle. Owing to their very low numbers, recovered domesticated animals cannot be considered to have been important at the site.

Conclusions

Fårevejle is best interpreted as a seasonal hunting location where EBK hunters came specifically to procure particular resources over a restricted period of the year. Hunting was for red deer, wild boar, and roe deer and for the procurement and consumption of oysters. If encountered, the occasional fox was killed. In the nearby Lammefjord, fishing for members of the cod family and flatfish took place. The site was not provisioned; resources recovered here were hunted nearby. Due to the overwhelming numbers of mollusk shell, hunting of terrestrial game may have been a secondary occupation. Visits were highly seasonal, centered on the late spring and early summer months, with numerous visits over a number of years resulting in the accumulation of the shell-heap. Over time, red deer use did not change much while roe deer and wild boar use shows an inverse relationship. The rather abrupt changes in abundance of these two species hint at multiple-year visits where local availability of these two species locally may have fluctuated. There is no clear focus on a single age of individual as all ages are represented. Nevertheless, there are a significant number of younger animals in the assemblage. In sum, Fårevejle is an example of a seasonally visited hunting camp, part of a collector strategy employed late Mesolithic hunter-gatherers in Northwest Zealand.

Chapter 6: Trustrup

Introduction

Trustrup is an EBK settlement located along what was an inland lakeshore during the Atlantic period. In general, very few inland EBK sites have been reported, and those that have are predominantly restricted to the Åmose with few exceptions (Gotfredsen 1998, 2003; Noe-Nygaard 1995; Rowley-Conwy 1993-1994). While poorly preserved, Trustrup represents a rare inland seasonal extraction site, and therefore is worthy of analysis. The site also is located almost precisely between the reported Åmose sites and the other published sites presented in this work, allowing a more complete view of human activity in the region and an opportunity to connect the two regions in terms of faunal economy (Price and Gebauer 2005).

The Bone Material

In total, 20,790 bones were recovered from excavations at Trustrup. Of those, 1251 (6.0%) are identifiable to species or genus. Of the identifiable bone, the vast majority (1,241) is mammalian, making up 99.3% of the identifiable sample. The remaining proportion of the identifiable samples are amphibians and fish, in total only 10 bones.

At a minimum, 14 species of mammal are present in the assemblage (Table 6.1). One genus of amphibian and three genera of fish are represented. It may be that 15 species of mammal are present, as non-diagnostic elements the grouped ovicaprid taxon were identified and, therefore, one or both of the two could be present. The same is true with the amphibian and fish remains, where multiple bones identified only to the generic level may represent more than one species.

Mammals	NISP	MNI
Cervus elaphus	508	9
Capreolus capreolus	443	14
Sus scrofa	198	6
Canis familiaris	47	2
Castor fiber	20	1
Equus caballus	7	1
Lutra lutra	6	1
Capra/Ovis	3	1
Felis silvestris	2	1
Martes martes	2	1
Vulpes vulpes	2	1
Halichoerus grypus	1	1
Scruius vulgaris	1	1
Bos taurus	1	1
total	**1241**	

Amphibians	NISP	MNI
Bufo sp.	2	2
total	**2**	

Pisces	NISP	MNI
Gadus sp.	2	
Esox sp.	5	
Siluris glanis	1	
total	**8**	

Table 6.1: Relative abundance data

The only small mammal identified is the red squirrel. While small mammals found at Mesolithic sites are usually not archaeological due to their burrowing behavior (Aaris-Sørensen and Andreasen 1992), red squirrels found in such contexts are usually present because of human action, as they do not burrow, and they have soft fur. Therefore, this species is considered to have been a fur animal taken by hunters at Trustrup but was still of very low abundance given the nearly complete paucity of the species at the site.

The majority of the mammal sample is red deer (40.0%), roe deer (35.7%), and wild boar (16.0%) in terms of NISP, as is typical for Ertebølle sites (see Enghoff 2011). In terms of MNI, these taxa dominate as well, but roe deer are the most common. The two domestic dog individuals represent the only other taxon aside from the big three of which more than one individual is found. Other domesticated animals are ovicaprids, cow and horse.

In total, all domestic forms represent around 4.7% of the mammalian assemblage, with the dog being the best represented tame species, comprising 3.8% of the mammalian remains. While the differentiation of cattle and auroch is problematic in the Stone Age, the local extinction of the wild form on Zealand by the Ertebølle period establishes that the *Bos* material from Trustrup is domestic (Aaris-Sørensen 1980; 2009). However, only the domestic dog was found in unmixed cultural layer deposits and is the only domesticate that can be confidently attributed to the Ertebølle culture. Therefore, it is best to consider domesticates other than dogs as incidental to the economy of the site. Very low in number, they are not considered to have been contributory and they probably are not Mesolithic in date.

Low numbers of fur mammals including the fox, wildcat, European otter, beaver, red squirrel and pine marten were recovered, and comprise only 2.6% of the mammalian sample. Therefore, they were undoubtedly of minor importance, and none of their number is represented by more than a single individual. Of these, the best represented species is beaver, which makes up 1.6% of the mammal sample.

Of particular note among the identified bones is the canine tooth of a grey seal. Trustrup is approximately 10km from the nearest modern marine environment from which this tooth could have come, probably indicating that this specimen was carried by man to Trustrup. While it is unclear how far from the sea Trustrup was during the Atlantic period, even if the distance was similar to what it is today, this finding is not surprising given the marine focus of much of the lives and diets of EBK hunters and indeed seal hunting at several EBK sites on Zealand (Fischer et al. 2007; Ritchie et al., in review; Møhl 1971). This find clearly shows a connection with marine environments not too far from Trustrup and clear evidence of movement to or from the coast.

Bird remains were rare at Trustrup. Due to the high degree of fragmentation (see below), none of the remains were determinable to even the generic level, although several duck-sized elements were present and are probably waterfowl. Aside from this, birds are reported as present at Trustrup and will not be interpreted further. Similarly, amphibian remains recovered from Trustup include two specimens, both determined to the toad genus *Bufo*. Due to low representation, lack of evidence of use by man, and the potential for amphibians to find their way into archaeological deposits, particularly bog deposits, these remains will not be interpreted further but are mentioned as present.

Remains of fish were similarly reported in low numbers from Trustrup. Not having been previously reported, the low numbers recovered (ca. 30 bones) were identified by Ken Ritchie (personal communication). Eight specimens were confidently attributable to three genera, with only one attribution to species level possible. The pike and cod families are represented (genera *Gadus* and *Esox*) by unknown species, while a single specimen is confidently attributed to the wels catfish (*Silurus glanis*). While it is possible more than three species are present among the fish sample, at a minimum, there are three taxa of fish at Trustrup.

In sum, the faunal sample is absolutely dominated by terrestrial mammals, and more specifically red deer, wild boar, and roe deer with low representation of fur animals. Fish, birds, amphibians and other taxa cannot be said to have been of any great economic importance at the site due to their low representation.

Taphonomy

The bone from Trustrup is rather homogenous in its appearance and overall condition, without much variation. In general, the bone is tan to light brown and is never shiny. The surface is rarely hard and completely intact, making most surface modifications at least partially obscured and often completely obscured. For this reason, quantification of surface modifications was severely hampered. The bone is often exfoliated, and the surface is always at least partially eroded, with usually around 1/3 of it gone. Some of the bone is weathered to the point that the texture is fibrous in patches. Surfaces over cancellous bone are almost always rounded or worn away, often exposing the spongy bone underneath. This is particularly true of formerly sharp articular surfaces, such as the trochlea of the distal humeri, which almost never retain their sharp edges. The only sharp edges are breaks of more robust cortical bone, in particular long bone shafts. This allows recording of some marrow fracturing and, in particular, some blow marks, although certainly not in all cases. In general, the material has a rounded, rolled appearance and is quite broken up. The poor condition of the material is not restricted to its physical characteristics, as chemically the bone exhibits signs of likely diagenesis as well, as shown by very atypical ratios of atomic carbon to nitrogen in the remaining bone collagen (this Chapter; Chapter 8). Partially as an effect of the degree of fragmentation, 515 of the 1240 mammal specimens attributable to species (41.5%) are loose teeth, indicating that in all likelihood, NISP values from this assemblage are highly inflated due to the degree of fragmentation, and comparative approaches to the material must be approached with caution.

The assemblage is best described as borderline between Behrensmeyer's (1978) Stages 2 and 3, but with most of the material closer to Stage 3. While some bone shows flaking and cracking, more often the bone surface has patches of rough, weathered compact bone and a rather fibrinous texture. The weathering usually does not penetrate more than a millimeter into the bone.

Following Noe-Nygaard (1995), the bone material is best described as fitting into Category 3. The bones do not have the characteristic Category 3 brown and beige spotted pattern; although the bone surface is worn away with a patchy porous texture and some cracking and exfoliation (Noe-Nygaard 1995). In terms of weathering, it appears that while Noe-Nygaard's (1995) Category 3 had weathering indicative of Behrensmeyer's (1978) weathering Stage 1 criteria, the Trustrup bones probably sat exposed to the elements somewhat longer than those described by Noe-Nygaard.

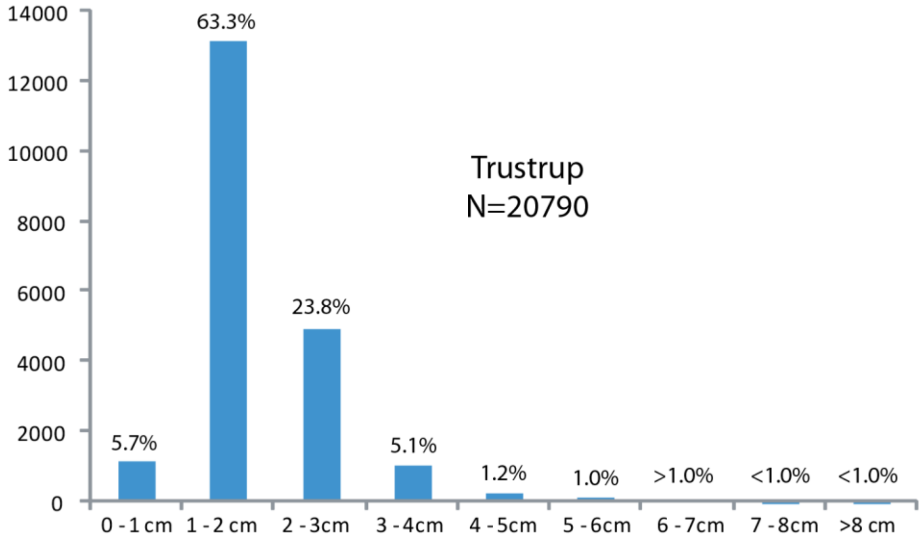


Figure 6.1: Maximum length of all bones recovered

Quantitatively, the material from Trustrup is very highly fragmented (Figure 6.1). Nearly all of the material is under a maximum length of four centimeters, with 63.3% of all bones between one and two centimeters in maximum length. In turn, the degree of fragmentation affects relative identifiability of specimens. Later in this document, a comprehensive discussion concerning the relationship between various quantitative statistics, sample size, and degree of fragmentation will follow (Chapter 9). In this specific case however, the extremely high degree of fragmentation affects interpretability in that reliable methods for aging and assigning seasonality were very often unavailable. In particular this was evident in terms of the lack of identifiable bird remains (the presence of which can indicate seasonal occupation), as well as the lack of a single maxilla or mandible of any of the three main species with more than two teeth in-situ. This prevents accurate ageing of the animals based on tooth wear. Further, the high degree of fragmentation precludes conclusive reconstructions of breakage, as oftentimes it is impossible to observe the full extent of bone breakage or reconstruct the steps taken to break down the bone. In sum, the high degree of fragmentation and preservation significantly limits the interpretations and methodological approaches possible when analyzing this assemblage.

Taken together, the above indicators of the quality of the bone material indicate a number of post-depositoinal processes probably related to the lakeshore sediments in which the bones were deposited. As the majority of faunal remains were recovered in matricies containing high carbonate levels (T.D. Price, personal communication), this fact, in conjunction with probable factors such as near-shore lake dynamics, seasonal temperature shifts, nearby springs, travertine precipitation and probably others (Ford and Pedley 1996), subjected the bones to a series of stresses resulting in partial encrustation, additional fragmentation, chemical diagensis, and ultimatey, the poor quality of the bone material.

Species Representation by Level

In order to determine the relative abundance of the most important species at Trustrup (red deer, roe deer, and wild boar), unambiguously provenienced specimens from the Peat, Mixed Marl, and Cultural Layers at Trustrup are compared in terms of NISP in Figure 6.2. MNI values are not appropriate for this type of comparison as they were low in number, and not calculated individually by stratigraphic layer. Aside from the three main species, other specimens are present in such low numbers that differences between stratigraphic layers are not interpretable in a meaningful fashion. The overall picture of representation by level is that of nearly unchanging relative abundance. Wild boar is perpetually the least represented of the three, always between approximately 10% and 20% of the material. Red deer and roe deer are of similar importance as collectively they make up most of the assemblage at any given time. Both are always better represented than boar. The focus of the animal economy at Trustrup appears to change little over time and can therefore be discussed as a single entity.

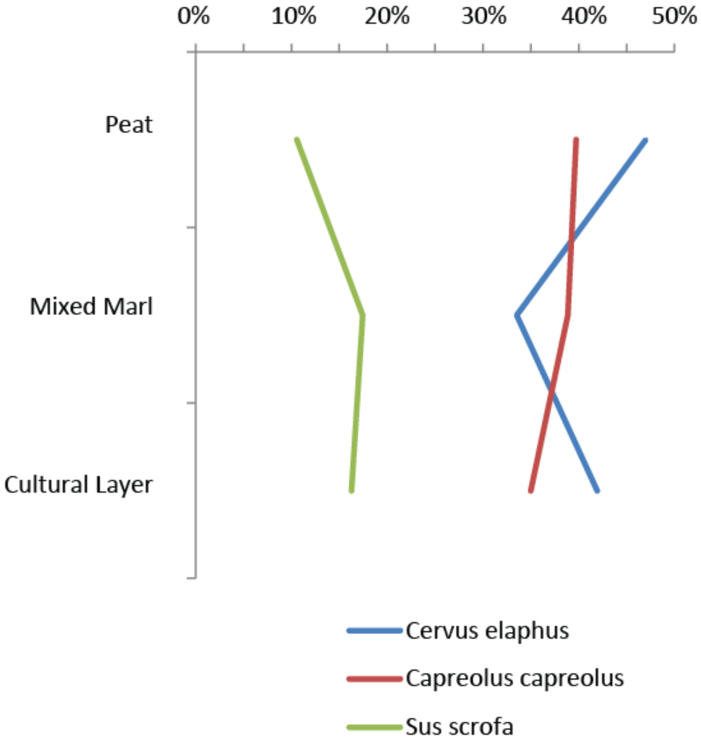


Figure 6.2: Representation by level (NISP)

Age Structure of the Finds

Fifty-two specimens come from juvenile animals, comprising 4.2% of all mammal specimens. However, it can be said that all ages of prey are represented, particularly in light of the presence of several very old individuals of a number of taxa (clear from extensive wear on several loose teeth), as well as intermediate wear stages among the collection.

Season of Occupation

Owing to the difficulties of ageing specimens from Trustrup as discussed above, and in concert with the lack of determinable birds, seasonal indicators are very sparse. At least one individual each of red deer and roe deer died with unshed antlers. The impression from Trustrup based on deer antler schedules is therefore vague, lacking conclusive evidence of season of occupation due to the presence of unshed antlers through much of the year as well as being based on only a single individual per species (Mitchell et al. 1977; Sempéré et al. 1992; Figure 6.3). It is best to simply state that the season of occupation of Trustrup is unknown based on the recovered faunal material.

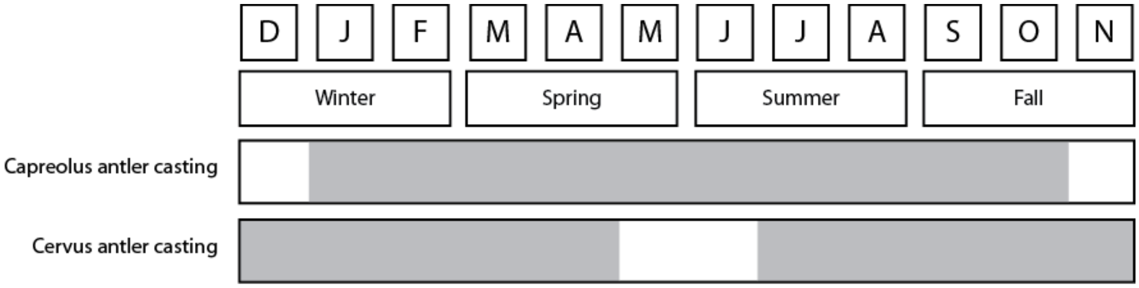


Figure 6.3: Cumulative seasonality data (darker colors indicate confidence)

Bone Modification

In part owing to poor preservation of the assemblage, very little of the bone exhibits unequivocal evidence of human modification. Only 24 specimens (1.9% of the mammal assemblage) exhibited cut marks, blow marks, other evidence of marrow fracturing, or other purposeful or incidental modification. Even fewer specimens showed burning, in all just 11 (0.9%). As the surface of the bone was in many cases worn through various taphonomic processes, the quantification of purposeful modification is surely an underestimate. While burning is similarly uncommon, this may not be as marked an underestimate as even when the surface of a bone is obscured, evidence of burning can often still be discerned. In all, it is possible to say that few of the bones were burned prior to deposition, but that it is unclear how many were modified in one way or another.

Body-Part Representation

Relative body-part representation was calculated for red deer and roe deer using %MAU and displayed graphically (Figure 6.4, calculations in Table 9.2). Percent MAU was not calculated for other taxa due to low representation of all elements likely to obscure all patterns or information that might be contained therein.

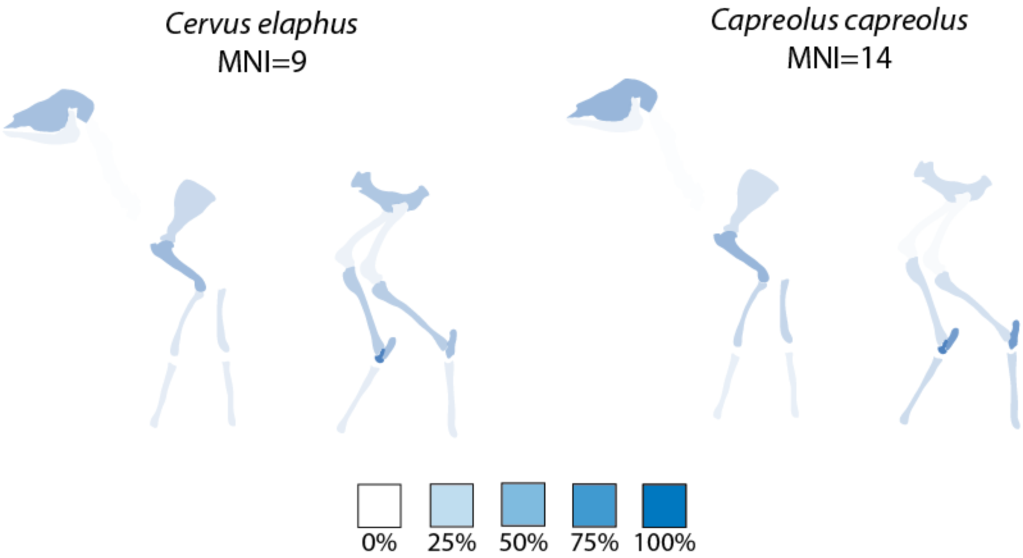


Figure 6.4: Percent MAU skeletal representation for roe deer (L) and red deer (R)

Between the two species, elemental representation is similar. First, bones that are denser are better represented, and more fragile bones are rarer (see Lyman 1993; Chapter 9 for further discussion). Second, steadily represented between the two species are dense bones, including humeri, tarsals, innominates, certain skull elements, and the cranial end of scapulae. Also, rarer in both species are the more fragile bones including much of the axial skeleton. This means one of two things. One, that both were being killed nearby and brought to the site whole where post-depositional density-mediated taphonomic processes acted upon the remains post-use resulting in similar body-part representation. The other option is that the two species were butchered in the same fashion elsewhere and brought to the site piecemeal, and this is the reason for the observed similarity in their body-part representation.

There is a rather significant size difference between red deer and roe deer (Geist 1998). Therefore, red deer and roe deer have the potential to be differently transported. One person can carry an unbutchered roe deer while such a feat would be nearly impossible for the much heavier red deer. This size difference is precisely why the first option, which concerns the hunting of both species near to Trustrup and being brought to the site whole and then deposited is probably the more likely scenario. What is found is simply that which is sturdier. Stronger more dense bones are preserved, and weaker, more fragile bones are not. This interpretation of the differential body-part representation is reinforced by the ubiquity of teeth in the assemblage, another hint that far more less-dense material was originally deposited at the site. Ultimately, this can be taken to mean that Trustrup was located in an area that EBK hunters went to in order to procure game, and not a site from which they ventured any great distance to hunt. A more in-depth and comparative discussion of this process in northwest Zealand can be found in Chapter 9.

Isotope Data

In all, 13 samples from several species of terrestrial herbivore, wild boar, and domestic dog were submitted for carbon and nitrogen isotopic analyses. Unfortunately, all samples (N=13) submitted from Trustrup fell outside the acceptable range of atomic ratio of carbon to nitrogen, indicating a high likelihood of diagenesis (White et al. 2001). Additionally, many cases showed impossible values (e.g. deer showing high enrichment similar to that expected of marine carnivores), and were therefore discarded. Also, due to the lack of useable samples, no specimens were submitted for direct AMS radiocarbon dating either, as based on the isotopic collagen results, there was little chance of success. Ultimately, this unfortunate result disallows any clear view of the local environment or human diet at the site, although some indication of the local environmental milieu can be discerned from samples from other sites in northwest Zealand (Chapter 8).

Discussion

The faunal assemblage from Trustrup is a good example of a poorly-preserved EBK assemblage of limited direct utility in isolation. The fauna recovered from excavations yields far less information than some even minimally better-preserved assemblages such as Fårevejle (Chapter 5). In general, not only is the material highly fragmented, but also it is clear that the preservation of the bone itself is poor as evidenced by the diagenetic bone chemistry. This is in stark contrast to Havnø, where the material is fragmented but exceptionally well-preserved chemically, probably owing to the high $CaCO_3$ content of the shell matrix (Chapter 7). Poor preservation and high degree of fragmentation have a snowball effect on interpretability in that one of the best indicators of season often comes from the ontogenetic ageing of teeth, which in this case was precluded by the lack of several teeth in-situ. With no ageable teeth, one of the best seasonal indicators was unavailable as a source of information about occupation at the site. The only other seasonal indicators available were two specimens of unshed antler from two species, a situation that occurs over much of the year and sheds little light on when exactly the EBK hunters at Trustrup were at the site. Further evidence that the degree of fragmentation is probably obscuring important seasonal information comes from the proportion of the assemblage that shows evidence of being juvenile. In all, 4.2% of all recovered animal remains showed evidence of being juvenile. In contrast, the proportion by the same measure at Asnæs Havnemark, a site where the material was less fragmented, was only 2.2% (Ritchie et al., in review), indicating that if the material had not been so pulverized, then much information probably could have been gleaned as there was abundant seasonality data from Asnæs Havnemark.

Ultimately, as little information was obtained about seasonality of occupation, butchery patterns, and other usual indicators used to obtain information about Stone Age economies, interpretations must rest upon relative abundance values and differential body-part representation. Little else provides much information about human behavior at the site.

As relative abundance changes little among the three main cultural material-yielding layers at the site, considering the assemblage as a whole is appropriate. This is a site for the hunting of the big three. No matter what statistic is used to quantify the faunal material, red deer and roe deer are the most important species at the site, followed by wild boar. As is typical of the measure, MNI values overinflate the abundance of lesser-represented species (Payne 1985). Fur animals which were probably trapped are much less common, but can be said to have been at least part of the economy at the site. Birds are represented in the assemblage, but no species identifications were possible. However, there are very few explanations for their presence aside from human hunting so there was probably some fowling going on. The character and intensity of such hunting remains unknown, however. Domestic dogs among the assemblage probably represent hunting companions. Everything else, including the other domesticated animals as well as amphibians and fish, can best be considered to have been tangential, or possibly unrelated to the hunting economy of Trustrup.

Differential body-part representation shows that red deer and roe deer were subjected to the same post-depositional taphonomic processes, which resulted in density-mediated destruction of much of the bone material. Similar patterns of destruction between the two species indicate that the starting point was probably the same, with the carcasses of both apparently butchered and deposited whole at the site. This is because of their dissimilar body size. If butchered elsewhere, there would presumably be at least some differences in what is represented in the material in the assemblage. Therefore, Trustrup was a locality that was almost certainly visited to obtain the big three, probably on a seasonal basis, during which some *ad libitum* trapping was going on. Prey were butchered there, and then the EBK hunters moved on.

Conclusions

Trustrup is a hunting site for red deer, roe deer, and wild boar. Some trapping was performed at the site, but the importance of this activity is at best interpreted as low. The site is of interest predominantly due to its location between the coast and the extensively published faunal assemblages from the Store Åmose (Noe-Nygaard 1995). It is unfortunate that the material is as highly fragmented as it is, as most potential sources of information of interest pertaining to faunal economies are obscured by the fragmentation and generally low quality of preservation of the material. Nevertheless, evidence obtained here points to a rather focused economy at Trustrup, one almost exclusively for the hunting of terrestrial game; red deer, roe deer, and wild boar. The low levels of trapping of fur animals, as well as other game such as marine mammals and even some fishing show that EBK hunters had the tool kit to obtain many prey at Trustrup, while remaining extremely focused in their hunting. While there is little seasonal evidence from the site, hunting appears to be going on near the site, and Trustrup appears to be a locality visited exclusively for the purpose of large game hunting. Therefore, it is probably best interpreted, regardless of the paucity of seasonal indicators, as a seasonal inland hunting camp for large terrestrial game.

Chapter 7:Havnø

Introduction and Problems

Shell midden mammal and bird assemblages are extremely hard to interpret. In general, there is a lack of significant amounts of faunal material recovered per excavated square, resulting in scattered finds both horizontally and vertically throughout the shell depositional events. Usually, bones are recovered in groups with several often articulating bone remains found together separate from other finds. For comparison, over 100 m^2 were excavated at Havnø yielding just over 21,000 bones of all sizes, while at the non-midden Ertebølle site of Asnæs Havnemark, just over 12,000 mammal and bird bones of all sizes were recovered from under 30 m^2 excavated. In other words, the density of bone finds is significantly lower at Havnø.

Perhaps the most important analytical problem involves the high degree of fragmentation of the bone material. Again taking Asnæs Havnemark material as a point of comparison, even the highly fragmented assemblage from that site yielded 2272 identifiable mammal, bird, and amphibian specimens, while at Havnø, only 1365 were attributable. This is particularly informative given the overall size of the assemblages, with Asnæs Havnemark yielding 12,202 bones in total (18.6% identifiable) and approximately 70% of the entire Havnø assemblage yielding at least 28,776 bones (4.7% identifiable). This low identifiability is probably attributable to a number of taphonomic factors (likely pre-depositional, post-depositional, and during excavation) which result in the bones being broken up beyond all recognition. Also, due to the crushing nature of the shells, few bones are larger than an oyster and often break up when removed from their original context. An example of this is seen in Figure 7.1 where, if removed from its original context, the ovicaprid mandible would immediately break up into smaller pieces. In this case, both ends of the mandible are missing. This is probably due to the limits of the protective extent of the oyster shell itself. Repeated many times, this results in even the largest bones to become highly broken-up by the time that they reach the analyst and present challenges concerning the ascertainment of all classes of zooarchaeological data.

Figure 7.1: Sinstral ovicaprid mandible in-situ in oyster shell (courtesy of Harry Robson)

Additional problems result from the complex stratigraphy of the shell middens themselves, which present often very convoluted and complicated pictures of deposition. This is particularly true at Havnø. Shell middens are usually accumulated over very long periods of time, resulting from the repeated deposition of small piles of shells, sometimes recognizable in profile as individual depositional events (Andersen 2007, 2008). The general effect of this mode of deposition is that there is often no clear way, save for radiocarbon dating of individual bones, of unequivocally relating the relative age of some specimens to others across the site, even in the case of very careful excavation. One possible way to mitigate such problems is to employ column samples, as has been done at Havnø on fish remains (Robson 2011). However, the mammal and bird faunal remains are less abundant across the site than fish remains, so any individual column sample might only contain a few attributable specimens. An example of this is column sample ACAA, which yielded many fish bones, but only 127 bones, of which only two specimens of frog (*Rana* sp.) and one indeterminate cervical vertebra from a duck-sized waterfowl were recovered. As a result, it is necessary to estimate as best as one can, which bones likely come from Mesolithic contexts as determined by associated lithics, ceramics, matrix shell size and composition, location within the midden, and, in rare cases, by directly AMS dating the bones themselves. Necessarily, some specimens must remain attributed to an unknown Stone Age epoch. At present this is the current state of affairs concerning the Havnø midden. The large numbers of recovered faunal remains from multiple and variable contexts have precluded stratigraphic separation, localization, and attribution to epoch for most of the bones. Therefore most of the assemblage must be discussed as being of undetermined age. However, those specimens of undetermined age are almost certainly Ertebølle and ENI TRB in age, based on the available ranges of radiocarbon dates from the site (Andersen 2008; Chapter 2). Some specimens have been assigned to epoch based on either a direct AMS radiocarbon date, or through discussions with the excavator Søren H. Andersen (personal communication). However, these are limited to the isotopic samples at present. In the future, as stratigraphic issues are mitigated, the separation between the Mesolithic and Neolithic at the site hopefully will be clarified.

Further complicating the picture is the transitional nature of the midden itself. AMS dates place occupation between 5000 and 3500 cal B.C., spanning the late Mesolithic Ertebølle culture and the earliest part of the Funnel Beaker Culture (Andersen 2008; Chapter 2). At or around 3950 B.C., agriculture arrives in Denmark, evidenced by animal husbandry, domestic cereals, and cultural change (Fischer 2002). This event leads to several problems. First, for reasons described above it becomes an issue to identify which materials are Mesolithic and which materials are Neolithic. In some cases, it is not possible to assign a given specimen. Second, present on Jutland during the period of occupation are two general classes of animals which are difficult to differentiate between the wild and domestic forms; wild boar or domestic pig, and aurochs or cattle (Aaris-Sørensen 2009). The possibility exists that both domestic forms and wild forms could have been taken or utilized at the same time, but often it is very difficult or impossible to distinguish the forms except in specific cases. Such differentiation is limited by the occurrence of specific diagnostic elements in appropriately complete pieces so that diagnostic measurements can be taken. This is partly a function of the fragmentation processes which have been discussed earlier in this chapter. Even then, not all measurements will yield unambiguous results due to overlap in size between wild and domestic forms. The resulting picture is highly incomplete and rife with ambiguity, but, nevertheless, some conclusions can be drawn. The data are reported below.

Previous Investigations and the Present Study

Previous publication of the fauna from Havnø reports either data on the presence or absence of specific species or actual counts of the bones recovered (Madsen et al. 1900). However, relative abundance data are reported inconsistently. In some cases, individual specimens are quantified while in other instances, the number of specimens is simply listed as "present" or "many". In total, 15 species of birds and 13 species of mammal were reported which includes two species of rodent. With one exception, all species of mammal reported are re-confirmed here, except for the yellow-necked mouse which was not encountered. Of the 15 species of birds, only four were reconfirmed in the current investigations. This is of particular interest given the aggregate total species of bird now reported. The nine species unique to the early sample include the tundra swan (*Cygnus bewickii*), long-tailed duck, common eider (*Somateria mollissima*), brant goose (*Branta bernicla*), great crested grebe, herring gull, great cormorant (*Phalacrocorax carbo*), Dalmatian pelican (*Pelecanus crispus*) and hooded crow (*Corvis cornix*) (Madsen et al. 1900). With the Winge and current samples combined the total number of avian taxa from Havnø totals 34, an extremely rich bird assemblage for a Stone-Age site.

In addition, two quantifications are of particular note and importance given the results of the present study. The two best represented bird species or classes of bird species from the Winge analyses were swans (NISP=67) and the velvet scoter (NISP=68) while all other species of birds were represented by only few individuals. In consideration of the current sample and new data, this confirms the focus among the bird remains on the procurement of swans and velvet scoters.

Taphonomy

In general, the Havnø material, although well preserved, is highly fragmented. The degree of fragmentation can be predominantly attributed to various taphonomic factors within the midden itself, including the crushing weight of the shells, as well as possibly other processes such as the off-gassing of the byproducts of rotting shell parts. Most of the rare human alteration of the material is probably obscured by the post-depositional processes. Chemically, there is little evidence of collagen degradation or diagenesis (see isotopic studies below), and this is probably attributable to the high $CaCO_3$ content of the shells themselves, which acts as a buffer and prevents degradation in the bone (see Noe-Nygaard 1987). The bone is a dark sand color, with no mineral build-up on the surface. The bone surface is often well-preserved, with any sort of human-marks/gnawing usually visible. The bones are heavy, not brittle at all, and generally fresh-looking. However, because of the high degree of fragmentation, it is often difficult to determine most fragments to species.

While preservation is largely homogenous, it is acknowledged that there is some variability in the degree and quality of the bone. The weathering stage most applicable to the material is Behrensmeyer's (1978) Stage 0. The bone shows no cracking or flaking due to weathering. The bone surface is not hard and shiny, however. The bone surface is sometimes corroded, and some of the bones are light, indicating that they have lost weight. In addition, some of the surfaces have been exfoliated. Surface modifications are very often visible. Taking the above into consideration, when fitted into Noe-Nygaard's (1995) scheme for the Store Åmose, the Havnø material most accurately fits into category 3, but is well preserved for the metric.

In total, there are 28,776 bones in the Havnø assemblage analyzed here. Of these and regardless of their ability to be identified, 21,127 (73.4%) were measured to maximum absolute length and are shown in Figure 7.2. The measured bones consist of all materials excavated after 2004, and are considered to be representative of the degree of fragmentation at the site. The reasons for this are that initial research involved materials excavated from 2005 through 2010, and those materials totaled 13,291 bones (46.2%) of the sizes illustrated in Figure 7.3. With the addition of materials excavated in 2011, overall fragmentation changed little, indicating a high likelihood that the larger sample is representative.

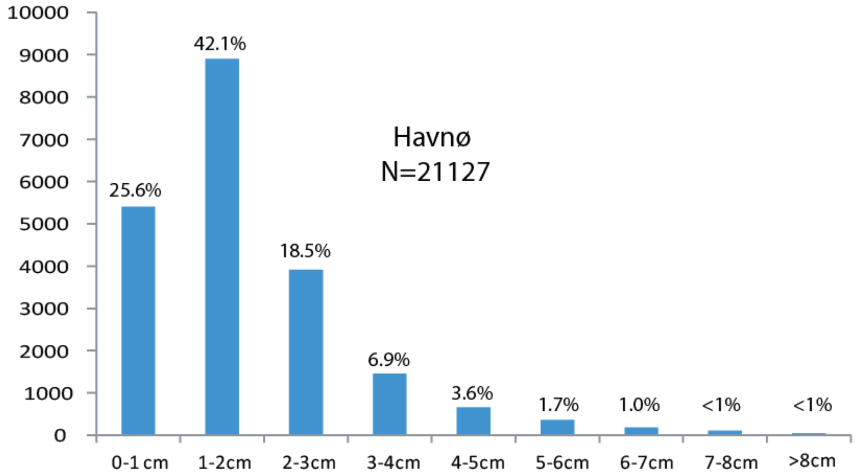


Figure 7.2: Maximum length of bones recovered, 2005-2011 excavations (73.4% of the assemblage)

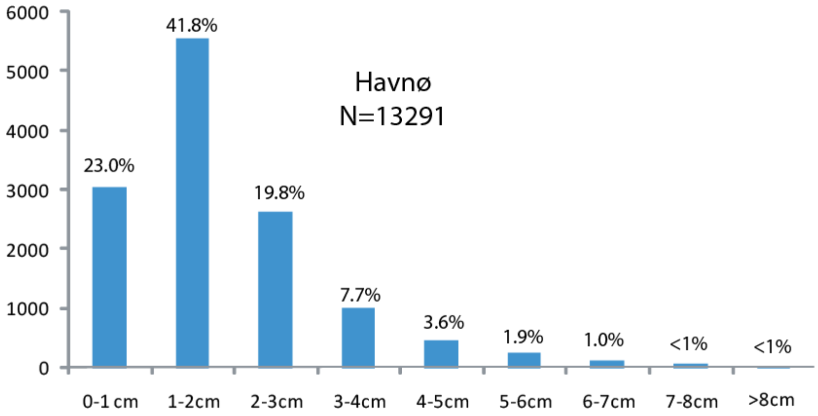


Figure 7.3: Maximum length of bones recovered, 2005-2010 excavations (46.2% of Assemblage)

The very high degree of fragmentation, in conjunction with the moderate representation of a number of species, precludes an estimate of taphonomic loss for any given species and indeed for the site as a whole. The best exhibited mammal taxon is represented by only eight individuals, and a full reconstruction of elements is not possible from the material present, disallowing an estimation of the number of fragments resulting from the breakup of complete elements.

In consideration of the possible causes of the high degree of fragmentation, any number of factors including predepositonal action of Stone Age man (e.g. marrow fracturing, cooking, etc.), after deposition taphonomic processes such as marine transgressions, and excavation and curation techniques may be contributory. In the case of this assemblage, and perhaps shell middens in general, the comparative approach of this study allows for more to be said in this arena, and some tentative conclusions can be made about the ultimate causes for the overall fragmentation of bone in this midden. As established above, the material from Havnø is highly fragmented. In comparison with the other shell midden in this study, the heap at Fårevejle (Chapter 5), the two assemblages overall are nearly identical in terms of overall size of the fragments recovered (Figure 7.4).

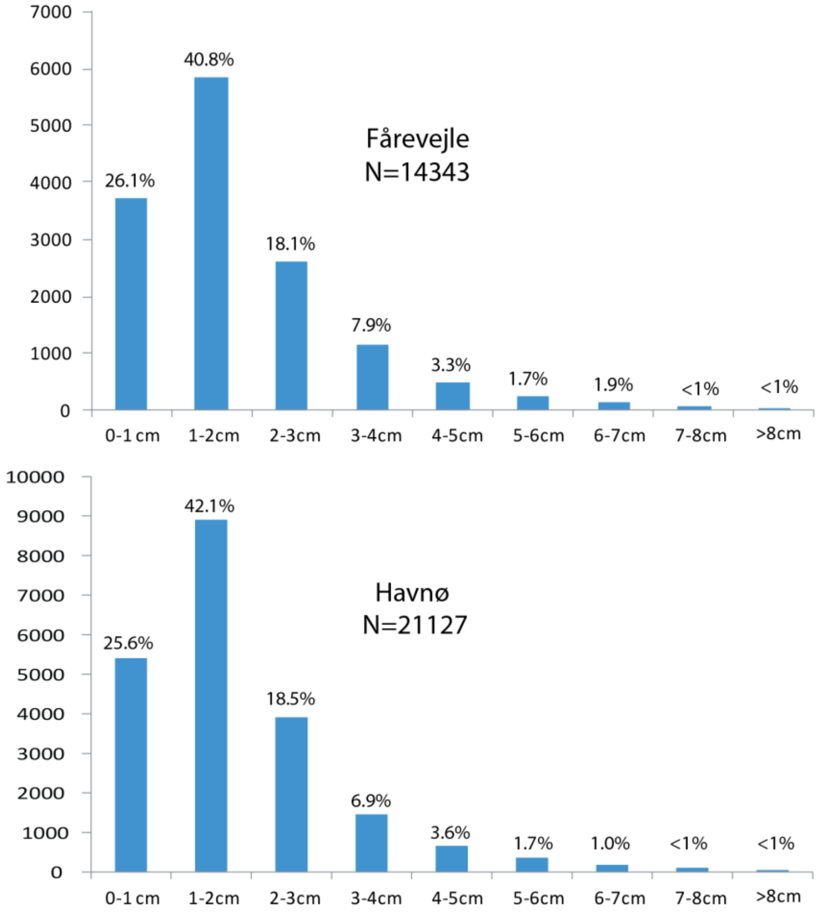


Figure 7.4: Maximum length of bones recovered from the shell-heaps at Havnø and Fårevejle

Under a strict Kolmogorov-Smirnov statistical test, the two assemblages do not differ statistically (Test statistic 0.0124643, $\alpha=0.05$, P= 0.07). In other words, the sum total of taphonomic effects is identical, regardless of what those processes are in particular. However, this similarity only partially permits delineation of which factors are contributory as there clearly are some differences. Foremost, the material from Fårevejle shows a high degree of weathering, while the Havnø material does not. In fact, the two are quite dissimilar, as the Havnø assemblage was buried shortly after deposition and the bones lay exposed only for a short time, while the Fårevejle assemblage shows extensive weathering due to exposure to the elements (Chapter 5). Basically, two very distinctive assemblages entered the archaeological record, but came out the same.

This discrepancy indicates that the processes resulting in the similar degree of fragmentation acted upon these assemblages after deposition and burial, but before analysis. There are a number of factors that affect a bone assemblage throughout its history. Marean et al. (2004) define six stages influencing skeletal element survival at which destruction occurs owing to variable actors. First, the agent of accumulation acts on the bone. Second, animal agents may act on the bone after discard by the accumulating agent. To this, I add that at this stage the natural elements may also act on the assemblage. Third, natural agents affect the bone in the sediment. Lastly, the final three steps outline how the archaeologists and analysts affect the assemblage during recovery and analysis (Marean et al. 2004). In this case, the last three stages are moot, as in both cases all fragments were saved for study, and I performed the same procedure on both assemblages. What is interesting is that, given the differences in weathering between the assemblages, the effects of the natural elements diverged after the bones were discarded by their accumulators. What this suggests is that the similar degree of fragmentation was introduced at Stage 3 (Marean et al. 2004: 72), while the bones were embedded in their depositional matrix. So, something about the shell middens themselves created the equifinal result.

Taking the above into account, the overall length of the bones is always less than the usual size of oyster shells from the two sites. It is suggested here that the limiting taphonomic process resulting in the observed degree of fragmentation is mechanical, not chemical. This is because the bones retain their pre-depositional appearance in which the degree of weathering is easily identifiable. In this regard, the concave aspect of the shells may protect smaller bones, but the edges of the shells in contact with adjacent shells under intense weight, causes the reduction of larger bones. Overall, the similarity between the sites hints that many shell midden assemblages may in fact be highly similar in overall extent, and may be highly comparable in studies of variability of resource use across the Mesolithic and Neolithic transition.

Taxa and Identifications

In total, 16 species of mammal are present, including up to four domesticated species. There are 23 species of birds. All taxa are listed in Table 7.1. In addition to those species listed, a number of rodents and amphibians were recovered. Taxa identified included the bank vole, water vole, yellow-necked mouse, field vole (*Microtus agrestis*), and brown rat (*Rattus norvegicus*). These were not extensively analyzed for several reasons, all related to the fact that as they are probably not archaeological (Aaris-Sørensen and Andreasen 1992). First, the rodents were almost ubiquitously found in small piles containing complete skeletons within the shell layers, indicating that likely these animals burrowed into the shell heap and died there well after deposition of the cultural layers. This pattern does not follow with the other faunal remains in terms of how they were found as generally, whole skeletons of non-burrowing species are not found intact. This is particularly true of fish remains of similar size to the rodents, which often are found with just several bones together, not as more complete skeletons. Second, in general, small mammals are not archaeological in Stone Age sites unless they show clear evidence of processing, and in this case no such evidence was found (Aaris-Sørensen and Andreasen 1992). Finally, among the faunal remains was found the brown rat, a species not present in Denmark until the 18th Century (Aaris-Sørensen 2009). This certainly shows the invasive nature of many of these smaller species, and therefore indicates that they should not be included as part of the archaeological assemblage. Further, at least one frog of the genus *Rana* was also recovered, but similar to the other taxa, is not considered archaeological.

The assemblage includes at the very least 175 specimens of domestic species, comprising 14.8% of the identified mammal sample in terms of NISP. Domestic species confirmed at the site include 58 dog specimens, 105 ovicaprids, and 12 specimens of domestic cattle. Therefore, 9.9% of the assemblage in terms of NISP is attributable to domestic species associated with early agriculture in Denmark as dogs were already present in the Mesolithic. The overall count of total domesticates is surely an underestimate as within the assemblage are 394 swine specimens, either wild or domestic, which probably contain domestic pig. The same is true of 272 specimens which, conservatively, can only be assigned to the genus *Bos*, a sample of which definitely contains domestic specimens as well given their dominance in the attributable sample. In all, only 12 bones could be measured and confidently assigned to having come from domestic cattle and only a single specimen was attributable to a male auroch (Table 7.2; criteria from Degerbøl and Fredskild 1970).

Species	**NISP**	**MNI**
Sus scrofa	394	8
Bos taurus	12	
Bos primigenius	1	
Bos sp.	272	7
Cervus elaphus	192	3
Halichoerus grypus	48	
Phocidae	38	3 (all taxa)
Capra hircus	21	
Ovis aries	9	
Capra/Ovis	75	4 (all taxa)
Canis familiaris	58	2
Capreolus capreolus	51	3
Lutra lutra	5	1
Castor fiber	3	1
Alces alces	2	1
Vulpes vulpes	2	1
Equus caballus	1	1
Felis silvestris	1	1
Martes martes	1	1
total	**1186**	

Species	**NISP**	**MNI**
Melanitta fusca	53	21
Cygnus bewickii	10	
Cygnus cygnus	27	
Cygnus sp.	38	6 (all taxa)
Melanitta nigra	4	1
Terdus torquatus	3	
Terdus merula	3	
Terdus sp.	3	1 (all taxa)
Aythya marila	3	
Aythya ferina	2	
Aythya sp.	1	3 (all taxa)
Mergus serrator	8	2
Accipiter gentilis	4	1
Anas querquedula	1	1
Anas penolope	1	1
Anas sp.	3	1
Alca torda	2	1
Bucephala clangula	2	2
Luscinia luscinia	2	2
Nucifraga caryocatactes	2	1
Penguinis impennis	2	1
Podiceps ruficollis	2	1
Spatula clypeata	2	1
Buteo buteo	1	1
Mergus albellus	1	1
Pyrrhula pyrrhula	1	1
Uria aalge	1	1
total	**179**	

Table 7.1: Relative abundance data (all levels)

Specimen	Element	Side	Measurement/Metric (mm)	Species
XYO-8	astragalus	R	GLl/68.3, GLm/57.0, Dl/37.3, Bd/43.6	*Bos taurus*
AJR	astragalus	R	GLl/68.3, GLm/62.1, Dl/37.1	*Bos taurus*
GV-1	astragalus	R	Bd/41.7	*Bos taurus*
AHS	astragalus	L	GLl/70.0	*Bos taurus*
EPA	astragalus	L	GLl/68.2, Dl//38.1	*Bos taurus*
XYO-9	calcaneus	R	GL/135.0	*Bos taurus*
QAO-2	1st Phalanx	L/pair	SD/20.6	*Bos taurus*
MMJ	1st Phalanx	L/pair	SD/26.1, Bp/32.1	*Bos taurus*
QBE	1st Phalanx	R/pair	SD/25.5, Blpe/57.0, Bp/29.5	*Bos taurus*
OE	1st Phalanx	L/pair	SD/24.0	*Bos taurus*
AJV	1st Phalanx	L/pair	SD/33.0, Blpe/70.3, Bp/41.6	*Bos primigenius*
MBP	metacarpal	L	Bp/60.6	*Bos taurus*
HH-3	metatarsal	L	Bp/45.2	*Bos taurus*

Table 7.2: *Bos* measurements and species determinations (following Degerbøl and Fredskild 1970)

All other *Bos* remains were incomplete, ambiguous or not diagnostic for differentiating the two species. However, even in cases where measurements could not be taken, oftentimes clear size differences give some indication of what species a specimen may have been. A clear example of this is seen in Figure 7.5, where specimen QBE on the right is a confidently identified domestic cow, and the much larger specimen AJV to the left is from an auroch also shown by diagnostic measurements. While these specimens are able to be differentiated with certainty, many other non-confident *Bos* sp. specimens show a similar discrepancy in size.

Figure 7.5: Size comparison between 1st phalanges of *Bos* congeners. QBE on the right is a cow and AJV on the left is an auroch.

Unfortunately, no specimens from swine were appropriate for identifying a domestic pig and therefore, wild boar and domestic pig are grouped together. Whether or not domestic animals are included within the sample remains an open question. This is perhaps the most perplexing aspect of the assemblage as swine are the best represented species at the site and, unfortunately must remain undifferentiated because of the possible coexistence of the two species, possible inbreeding with wild and domestic species in part due to husbandry strategies, and the possible resulting spectrum of wild to domestic varieties (Albarella et al. 2007). In addition, appropriate measurements were not numerous enough to attempt to determine if there was a bimodal distribution of sizes, often an indicator of wild and domestic populations (Rowley-Conwy 2003). In the absence of diagnostic elements and measurements, this ambiguity must remain.

Terrestrial wild game is represented by red deer, roe deer, and wild boar, common finds in Danish Mesolithic and early Neolithic contexts (Enghoff 2011). Among the swine, it can be assumed that wild boar are represented due to the enormous (albeit unsuitable for measurement) size of some of the specimens. Red deer and roe deer are both present, but the two together only make up 20.0% of the assemblage, a highly unusual situation for both Mesolithic and early Neolithic sites. Even with an overestimate of all the swine being wild boar, the big three only comprise 53.7% of the assemblage. The least represented taxa of the "big three" are the roe deer, comprising only 4.3% of the mammals at the site. There are fewer roe deer than domestic dog.

Only one taxon of seal is confirmed, the grey seal. Some of the seal remains can be attributed confidently only to the class of seal (Phocidae), so the possibility exists that some, if not all, of the other three species present in Denmark at the time (Aaris-Sørensen 1998, 2009) may be among their number. Fur mammals are relatively rare. Otter, beaver, fox, wildcat, and pine marten are all present, but represented by only a few specimens. Two elk bones are present, as is a tooth of a horse. Subsequently, these two are not further discussed due to their underrepresentation, as well as the possibility that they may be from later periods (the horse).

The bird assemblage is very rich for a Stone Age site, with 23 species of bird confirmed and a number of specimens with clear indications of butchery in the form of cut-marks. With previous investigations at the site also taken into consideration, the number of species is even larger (see below). The birds are waterfowl of various sizes, diving birds, seabirds, smaller passerines, and raptors. The best represented individual species is the velvet scoter, a duck-sized bird and the largest of the scoters (Peterson et al. 1993). Of the birds, this species comprises 30.0% of the material, but, more importantly, 21 individuals. This represents a clear focus on the taxon at Havnø. The reasons for this are unclear, given the clear availability of other, similar-sized taxa which are also represented in the faunal assemblage. If grouped into the general class of “swan”, *Cygnus* sp. are the best represented class of bird (in terms of NISP) and overall, swans were a major target for hunting at the site although in terms of individuals their numbers are much smaller than the scoters. All other species are represented by just a few specimens, and while useful for seasonal assessments, probably were not of major importance to those living at, or near, the shell-heap.

Fish

While not a direct part of this study, focused studies of particular components of the fish assemblage have previously been published previously. The bone material recovered by the Second Kitchen Midden Commission contained only seven fish bones, including eel and flatfish (Madsen et al. 1900). Ritchie (2010) recently described a sample of 330 identifiable fish bones from the midden, which were dominated by eel (72.7% of the sample) and consisted of fish from nine families. Further, the presence of members of the family Belonidae, while small in number, may indicate spring or summer occupation (Ritchie 2010). Other conclusions were not presented given the small sample. Robson et al. (in prep, unpublished data) report a single column sample through the midden, which gives some picture of the change over time in use of fish, as well as a general impression of what is found among the shells.

In total, 306 individual bone specimens could be identified to species, representing the second largest sample yet published from the midden (Robson et al. in prep; Ritchie 2010). In general, most species are brackish water taxa, with only 10.2% of the material deriving from marine fish (Robson et al. in prep). Most of the bones, similar to those reported by Ritchie (2010) were eels, in particular the European eel (*Anguilla anguilla*), which comprised 71.2% of the material. The next best represented species is the three-spined stickleback (*Gasterosteus aculeatus*) which makes up 17.6% of the sample, followed by flatfish and gadids. In all, the column sample material derived from ten families of fish, not all identifiable to species but the majority of which were migratory species. The transitional nature of the published fish data, despite the small sample size, indicates that the dominance of eel fishing at the site continues across the transition between Mesolithic and Neolithic levels at the site, indicating continuity in practice (Robson et al., in prep).

Age Structure of the Finds

Of the mammal, and bird bones, 219 showed some evidence of being younger than a mature adult. This is 16.0% of all of the identified specimens. This is an underestimate, as in all cases even a gross assessment of the age of the animal was not always possible. Further, while evidence of being subadult may be present, oftentimes such evidence is not useful, particularly given the difficulties establishing the firm age of an animal at death from epiphyseal fusion given the various speeds which this process progresses in the mammal body (Noe-Nygaard 1987). Specimens aged more confidently are listed in Table 7.3.

Specimen	Taxon	Element	Age
VXV	*Sus* sp.	scapula	ca. 8 months
ADAH	*Sus* sp.	scapula	2-8 months
PNX-1	*Sus* sp.	scapula	2-8 months
XOL	*Sus* sp.	scapula	2-4 months
AJG	*Sus* sp.	tibia	7-9 months
VWV	*Sus* sp.	tibia	4-7 months
XPD	*Sus* sp.	tibia	4-7 months
ADFA	*Sus* sp.	tibia	3-6 months
XHW	*Sus* sp.	tibia	6-8 months
ADEF-4	*Sus* sp.	radius	4-7 months
ADFC-1	*Sus* sp.	radius	4-7 months
AKU	*Sus* sp.	metapodial	3-5 months
KK	*Sus* sp.	metapodial	3-5 months
AHAN	*Sus* sp.	mandible	16-24 months
UCE	*Sus* sp.	mandible	18-36 months
MAY-1	*Sus* sp.	maxilla	18-36 months
MFB	*Bos* sp.	3rd phalanx	ca. 2 weeks
ERU	*Bos* sp.	2nd phalanx	<1 month
EEY	*Bos* sp.	metapodial	<1 month
ADKQ	*Bos* sp.	innominate	fetal or neonatal
YDA	*Bos* sp.	1st phalanx	1-3 months
XZF	*Capra/Ovis*	scapula	fetal or neonatal

Table 7.3: Ages of specimens

It must be noted that among the ageable specimens, the entire group could possibly be either entirely domestic specimens, or nearly entirely wild with the single exception of the fetal ovicaprid specimen. This underscores the difficulties raised in the above discussion of the distinction between wild and domestic forms of *Bos* sp. and swine. In addition, some specimens could be from the same individual, and in some cases, probably are. An example of this are specimens AKU and KK, which were paired metapodials and were exactly the same size and may have come from the same individual. Essentially, the fact that it is not possible to discern wild and domestic forms in this sample nearly completely reduces its utility. This is because little is known about the mechanisms of early husbandry in the region, and therefore we cannot know whether breeding of domesticated animals was seasonal or not, as both are possible (Balasse and Tresset 2007). Therefore, as the seasonality of husbandry is unknown and whether or not domestic animals or wild animals are represented by the ageable specimens, an assessment of seasonality from this usually important line of seasonal data is not possible.

Of particular note are the juvenile *Bos* sp. specimens and the fetal ovicaprid specimen (Table 7.3). While all of the *Bos* sp. could be aurochs, this interpretation is unlikely, as this would require the inhabitants of Havnø either to have lived on the island with pregnant wild aurochs who subsequently give birth, or to have hunted newborn individuals elsewhere and brought them to the site. However, it is not completely impossible that a wild auroch mother could have been killed elsewhere, and the calf transported to the site alive, as it is not unheard-of for coastal hunter-gatherers to bring the live offspring of dangerous species to islands for particular purposes (Ohyi et al. 1980). It may be that the more likely explanation is that these young individuals are newborn domestic cattle, being raised locally, and then either dying at birth and/or stillborn, or being slaughtered at a young age. If this is in fact the case, this has profound implications for our understandings of early Neolithic use of the shell middens, but unfortunately cannot be proven without further study.

Season of Occupation

In a sense, the specimens that were able to be aged are disappointing in their composition in terms of understanding the seasonality of occupation at the site. The reproduction and herding strategies of early domesticates in the earliest Neolithic in south Scandinavia is largely unknown, as was discussed above. This understanding is largely the result of the sample as at present are only very small numbers of early Neolithic domesticate specimens available for study, and studies of seasonality as have been performed elsewhere using stable isotopes, for example, have not been performed (Balasse and Tresset 2007).

However, some consideration of the seasonality of Neolithic breeding of early domesticates has been undertaken for temperate northern Europe, and may inform interpretations of the findings from Havnø. Balasse and Tresset (2007) discuss how it is easier to constrict breeding season than extend it in domesticates, and that cattle and sheep raised outdoors in temperate northern climates tend to breed seasonally, with births corresponding to the period of highest food availability. They go so far as to say that in all likelihood, breeding was probably seasonal in Neolithic temperate northern Europe. This conclusion may be applicable to the earliest Neolithic animal husbandry at Havnø. If one were to argue for non-seasonal animal husbandry at Havnø, one would have to argue for a mixed seasonal and non-seasonal economy at the site, with Neolithic individuals hunting various wild resources and utilizing seasonally available mollusk resources, but at the same time expending the energy and time necessary to promote year-round breeding of their domesticates. Such a scenario requires a major investment of time and energy into a lifeway that would not have provided much of an advantage over other options, such as seasonal raising of domesticates. Therefore, the most likely explanation may be one of seasonal breeding of domesticates, with a conservative period of births for both domestic cattle, sheep, and goats sometime between March and July, the period of highest resource availability, with other species taken *ad libitum* over the course of the year. Ultimately though, this is speculative and a further line of inquiry possibly addressable using $\delta^{18}O$ studies on tooth development to assess seasonality of birth in domestic species.

Remains of birds provide the best view of seasonality at the site due to their large numbers and the preponderance of species that have similar seasonal patterns of visits to Denmark today. The overall picture of the birds is that mostly winter visitors are present, indicating that the majority of fowling took place in late autumn, winter, and early spring. Over 70% of the bird material is either swans or velvet scoters. The tundra swan and the whooper swan are present today in Denmark from the autumn to spring, and are considered to be a winter visitor to south Scandinavia (Génsbøl 1987). The same is true of the velvet scoter, which can be present from the end of July through April but is usually considered a winter guest to Denmark (Génsbøl 1987). Of the other species, the greater scaup (*Aythya marila*), common pochard (*Aythya ferina*), wigeon (*Anas penolope*), razorbill, common goldeneye (*Bucephala clangula*), spotted nutcracker (*Nucifraga caryocatactes*), little grebe (*Podiceps ruficollis*), northern shoveler (*Spatula clypeata*), smew (*Mergus albellus*), and common mure are all usually winter visitors to Denmark, appearing usually in the autumn and leaving again in the spring. However, several summer visitors were present also, including the ring ouzel (*Turdus torquatus*), garganey (*Anas querquedula*), and the thrush nightingale (*Luscinia luscinia*) (Génsbøl 1987). The common blackbird, red-breasted merganser, goshawk (*Accipiter gentilis*), common buzzard (*Buteo buteo*), and Eurasian bullfinch (*Pyrrhula pyrrhula*) are all usually year-round residents and therefore present no information concerning seasonality of occupation (Génsbøl 1987). To be conservative, no conclusions are made about the seasonal presence of the extinct great auk (Bengtson 1988).

The overall picture based on bird presence or absence, is that of the majority of the individual species found as well as the overall number of specimens being those that overwinter in Denmark. Of the three summer visitors, due to their rarity within the assemblage, it may be best concluded that these are being taken early or late during their summer visits, given the autumn, winter, and spring visits of the other species. In sum, fowling was probably a wintertime activity at Havnø.

Unfortunately, the overall picture of seasonality from the site is somewhat murky and less than precise.

In conjunction with the unclear animal husbandry practices of the time and the rather broad seasonality data provided by the bird sample, seasonality is not assigned with any degree of precision. But, the available seasonal evidence does allow a picture of when the site was occupied. First, Havnø was located on an island in the Stone Age and newborn or extremely young ovicaprids and cattle were recovered. It is unlikely that residents would be moving pregnant cattle during seasonal rounds, and therefore some cattle were probably resident on the island at least for much of the year. Second, the bird remains do show broadly a focus on the winter, indicating presence during that season and probably longer periods including the fall and spring. Third, fish data presented earlier in this chapter indicate at least some fishing can be localized to the spring or summer. Finally, the shells themselves represent a common late-winter or early spring resource (Rowley-Conwy 1984; Milner 2002). In all, a degree of sedentism, if not year-round occupation, is implied but ultimately this must be cautiously considered, as depending on the proportions of the material that turn out to be Mesolithic and which proportions Neolithic, the picture could turn out to be much less so.

Body-Part Representation

Given that Havnø was likely an island which was situated at a minimum of ca. 2km from the nearest land during the late Mesolithic and early Neolithic (Andersen 2008), it is important to understand how the fauna got to the site, and whether or not animals were hunted on the island, brought piecemeal to the site, or if evidence points to the site having been an island at all for the duration of its occupation based on the presence of the fauna contained in the assemblage. Difficulties arrive when quantifying differential body-part representation in assemblages where many species are represented, but each to a limited extent, as sample sizes are often far too small to arrive at meaningful conclusions. In this case, the big question is whether or not the largest animals (e.g. *Bos* sp. and red deer) were hunted on the island, kept on the island, or was brought out to the island after being butchered elsewhere. Most species are not useful for this determination due to a number of factors. First, small size precludes the establishment of transport of most species, as all of the birds, fur mammals, and smaller mammals could have been carried using canoes to the site. The only three taxa for which this would be entirely impractical are the auroch, domestic cow, and the red deer. Therefore, to bolster sample sizes and establish if there is differential representation or transport, MNE values were determined for these three species as a pool, and then normalized for body part, and converted to a percentage MAU value. Calculations are shown in Appendix VII, and the results are illustrated in Figure 7.6.

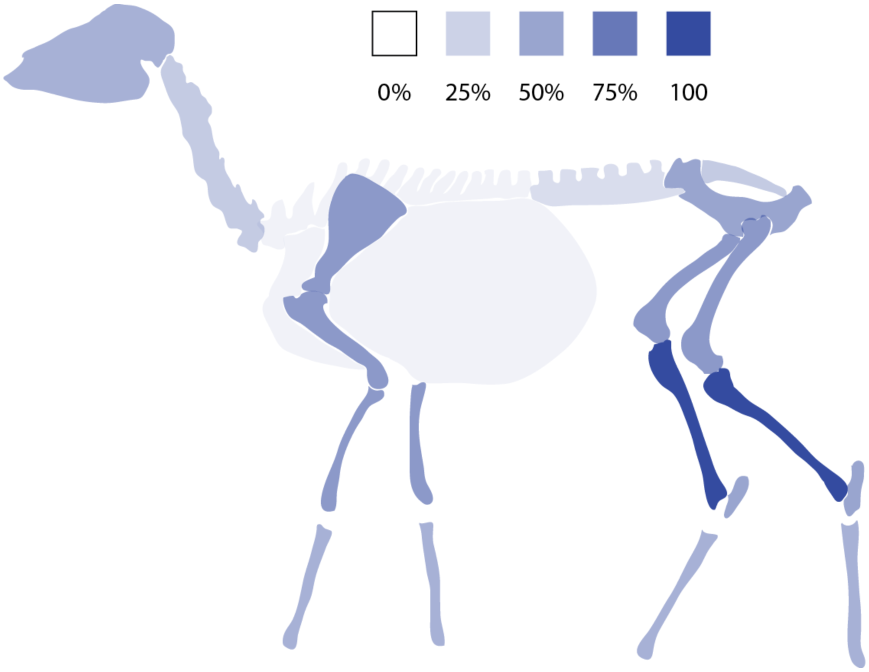


Figure 7.6: Percent MAU skeletal representation for pooled sample of red deer and *Bos* sp.

The results indicate that there is no clear pattern of differential body part representation due to butchery practices. Most elements of the appendicular skeleton are represented to similar degrees, indicating that when deposited, their numbers were likely equal. Elements of the postcranial axial skeleton are represented to a lesser degree but this is most parsimoniously attributed to density-mediated destruction, meaning that due to their fragile nature, abundance in the body, and difficulty differentiating these elements in a fragmentary state, their underrepresentation is most likely due to taphonomic processes and not to their lack of presence when deposited (Lyman 1993). Further, this interpretation is bolstered by the presence of cranial elements in amounts similar to those of the appendicular skeleton. In sum, the picture is that of large mammals being killed and all parts being brought to the site. Whether or not they were butchered at the site or butchered elsewhere with all parts brought to the site is an open question.

In a number of ways this raises more questions than it answers. Assuming Havnø was situated on an island, the data indicate, in conjunction with the possible domestic juveniles present in the assemblage, that cattle were most likely being raised on the island, at least for part of the year. This is not so strange a supposition as it would provide a natural means to corral the cattle, and enable grazing without the need for constant watchfulness or extensive fencing systems. However, this does not answer the question of the large deer, which were also brought to the site. If Havnø was indeed a small island, then this would indicate that a population of red deer may have been resident locally, an unlikely supposition given the size of the animal and their home range requirements (Geist 1998). Overall, the evidence points to a rather more complicated picture than an entirely isolated island in the middle of a body of water as red deer in the numbers recovered should not be present if Havnø was a truly isolated island. Either the island was tidally accessible to deer, not an island for the duration of its occupation, or all parts of large prey were being transported to via boat or sledge, depending on the time of year. Had larger deer been resident on the island, they would have been hunted out quickly or would have exceeded their biological requirements in short order. Due to the small sample of roe deer, it was not possible to assess the body-part representation of that intermediate-sized species.

Bone Modification

In all, very little of the assemblage is gnawed, with only 18 specimens (1.3%) showing evidence of having been gnawed by dogs. Unfortunately, the material was too highly fragmented for any meaningful reconstruction of the location of cut marks, but in all, 33 bone specimens (2.4%) had unequivocal evidence of being butchered using stone tools. One hundred and thirty-two specimens (9.5%) show evidence of marrow fracturing, including blowmarks and incidental fracture to access the internal marrow cavity. Very little of the material shows evidence of burning, with only 12 specimens (<1%) having unequivocal evidence of having been burned. In sum, evidence is equivocal as to any overall patterning of modification of the remains, and further interpretation is not wise based on the small sample size.

Isotopic Investigations

Extensive isotopic investigations of the stable isotopic ratios of carbon and nitrogen were undertaken on materials from both the Mesolithic and Neolithic layers at the site. These represent one of the largest single-midden assemblages of stable isotopic measurements available from southern Scandinavia. These are listed in Table 7.4, most probable cultural affiliation and age assigned by Søren Andersen (personal communication). The Neolithic sample from Havnø consists of 28 isotopic measurements, which among their number include three directly AMS dated specimens; two cows and a ovicaprid which were also analyzed for their carbon and nitrogen isotopic ratios (Chapter 2). The Mesolithic sample from the midden consists of two dogs, one roe deer, two red deer and one seal of uncertain species. The purposes of these isotopic investigations were multifold. First, wild species were analyzed in order to understand the local environment around the shell-heap at Havnø. Wild species, while often quite flexible in their environmental options, have clear preferences for specific environments, such that comparative isotopes may lend insight into the sorts of preferable environments that may be available around an individual Stone Age site, as well as how much variation is evident between wild species. Further, analyzing wild species allows the establishment of a baseline for comparing the diets of early domestic animals with their contemporary domestic counterparts (see Noe-Nygaard et al. 2005). To this end, 17 unequivocally wild specimens of aurochs, roe deer, red deer, and seal were analyzed. Further, eight specimens of swine were analyzed, representing either wild or domestic forms of pig (see above for difficulties with distinctions between taxa).

Lab #	VPDB	AIR	C:N	Number	Species
284469	-22.4	4.7	3.4	H-AJV	*Bos primigenius*
284470	-21.2	5.2	3.5	H-QXU	*cf. Bos primigenius*
284475	-22.4	3.9	3.3	H-QBE	*Bos taurus*
284483	-21.9	3.7	3.2	H-MBP	*Bos taurus*
284484	-21.8	4.2	3.3	H-JH	*cf. Bos taurus*
284485	-21.7	3.7	3.4	H-EOB-6	*cf. Bos taurus*
284486	-22.0	3.5	3.3	H-ANU	*cf. Bos taurus*
UBA-20176	-24.7	4.4	3.6	H-MFS-3	*cf. Bos taurus*
UBA-20177	-23.2	4.5	3.6	H-JFW	*cf. Bos taurus*
268289	-19.7	8.4	3.3	H-PLU	*Canis familiaris*
284451	-9.3	12.0	3.3	H-ST-1	*Canis familiaris*
284452	-11.8	11.7	3.6	H-UAD	*Canis familiaris*
UBA-20179	-11.0	12.1	3.5	H-ANM	*Canis familiaris*
UBA-20175	-21.9	5.1	3.5	H-ADGK	*Capra/Ovis*
268287	-22.0	4.6	3.3	H-HPA-1	*Capreolus capreolus*
284454	-21.5	3.7	3.3	H-OM	*Capreolus capreolus*
284455	-22.8	3.5	3.2	H-HSU	*Capreolus capreolus*
284456	-21.8	4.3	3.4	H-OHL-1	*Capreolus capreolus*
284457	-22.3	4.3	3.3	H-JRK	*Capreolus capreolus*
268288	-22.6	4.0	3.5	H-RYS	*Cervus elaphus*
284458	-21.6	4.6	3.4	H-ADEX	*Cervus elaphus*
284459	-21.9	3.5	3.6	H-YVO	*Cervus elaphus*
284460	-21.7	3.4	3.3	H-AGEA	*Cervus elaphus*
284471	-21.5	4.5	3.4	H-AGEG	*Cervus elaphus*
284472	-21.8	4.6	3.6	H-LDN-1	*Cervus elaphus*
284473	-23.2	4.7	3.3	H-QGU	*Cervus elaphus*
284474	-21.4	3.7	3.4	H-HWT	*Cervus elaphus*
284453	-16.6	12.0	3.5	H-PXA	*Halichoerus grypus*
UBA-20178	-11.7	14.6	3.6	H-AMV	*Phoca/Halichoerus*
268290	-22.2	4.6	3.6	H-POW	*Sus scrofa*
268291	-22.3	4.4	3.3	H-MLZ-2	*Sus scrofa*
284476	-22.8	5.0	3.6	H-ADFC-2	*Sus scrofa*
284477	-21.2	3.1	3.4	H-UFL-2	*Sus scrofa*
284478	-22.3	4.1	3.4	H-UBS	*Sus scrofa*
284479	-21.9	7.5	3.5	H-PUD	*Sus scrofa*
284480	-22.1	3.7	3.3	H-YWZ	*Sus scrofa*
284481	-21.5	4.6	3.6	H-ADFT	*Sus scrofa*

Table 7.4: Isotopic ratios of carbon and nitrogen (blue=Mesolithic, red=unknown age, black=Neolithic, UBA#s are directly AMS dated (Chapter 2))

The second reason for the isotopic analyses was to determine whether or not the domestic cattle at the site adhere to published data about differentiating contemporary domestic cattle from wild aurochs based on the breadth of their diet (Noe-Nygaard et al. 2005). This was to perform as a blind test as to the applicability of accepted criteria for the differentiating cattle and aurochs in the region as well as to lend weight to often tentative species identification of the domestic forms. In this case, seven specimens of domestic cattle and two specimens of aurochs were analyzed. The interpretation of these data is to be found in Chapter 8.

Third, taken in sum, these analyses were undertaken to understand the relationship between the diets of domestic species and wild animals living nearby possibly to learn more about the early practice of husbandry at the site. Early Neolithic assemblages are notoriously small, and Havnø represents a fine case where it is possible not only to analyze several specimens, but several specimens of several *individuals* from an early Neolithic context (Andersen 2007; Johansen 2006; Koch 1998). Some discussion of early cattle husbandry practices has grown out of numerous lines of evidence, starting first with discussions of the elm decline and suppositions proposing that the decline may have been due to extensive leaf-foddering of cattle, in which elm was preferentially selected to feed domesticates (Troels-Smith 1960). In the intervening half-century of research, other scholars have shown that Neolithic leaf-foddering, when it was practiced, probably involved the usage of a number of species of plant, and not singular or few taxa (Rasmussen 1989). More recently using isotopic evidence, scholars have placed the diet of early Neolithic cattle nearly entirely outside the range of contemporary wild deer, indicating that in all likelihood, early cattle were eating in more open environments than wild deer, and probably were not being leaf-foddered (Noe-Nygaard et al. 2005). However, this study relied on wild animals for comparison from just two sites, both located in an inland lake system, for comparison with early domestic cattle from across south Scandinavia. On a single-site level, a clear picture of the dietary relationship between early domestic cattle and their contemporary wild counterparts remains largely unclear. The results of these investigations in context with other isotopic data obtained in this project are discussed in Chapter 8.

Four specimens of domestic dog were analyzed for carbon and nitrogen isotopic ratios in order to understand human diets at the shell-heap. Three of the samples yielded extremely marine $\delta^{13}C$ (‰PDB) (-9.3‰, -11.8‰, and -11.0‰) and $\delta^{15}N$ (‰AIR) (12.0‰, 11.7‰, and 12.1‰) values. Further, one sample of these three was directly AMS radiocarbon dated to 5574±31 B.P. (uncal). These individuals therefore represent the highly marine late Mesolithic diet seen elsewhere throughout southern Scandinavia (Fischer et al. 2007). However, one of these samples, in fact the most enriched, is stratigraphically Neolithic in age. This may be an example of a Neolithic individual from Havnø continuing a Mesolithic pattern of protein intake, a situation not unheard-of for Denmark, as evidenced by the Neolithic man from Rødhals (Fischer et al. 2007). On the other hand, this specimen could have simply been disturbed, although most contexts within the midden are in situ. Finally, one dog specimen of unknown age yielded very terrestrial values of $\delta^{13}C$ (‰PDB) (-19.7‰) and $\delta^{15}N$ (‰AIR) (8.4‰). While it is stratigraphically unclear as to the age of this specimen, based on the terrestrial values its isotopes show, this specimen might be best placed as Neolithic in age, similar to other early Neolithic dogs and individuals from south Scandinavia (Fischer et al. 2007). The overall picture then in terms of human diet, is one of a dramatic shift in diet between the late Mesolithic and early Neolithic, from a diet reliant on seafood to one nearly entirely focused on terrestrial mammals. While not part of this study, similar preliminary analyses of the human remains from Havnø also reinforce this view (Robson unpublished data). Certainly part of the terrestrial diet, if not much of it, came from domesticated animals and plants.

In consideration of the terrestrial herbivores of all ages, domesticates included, the isotope values are quite homogenous, with significant and extensive overlap in all values. The Mesolithic sample from Havnø alone is extremely small, and therefore little can be said about the values except that they show typical results for late Mesolithic individuals from southern Scandinavia (Fischer et al. 2007). Part of the reason this sample is so small can be attributed to the fact that Mesolithic layers are buried deeper in the midden, and yielded less suitable material for analyses. The Neolithic sample is much larger, and again, the herbivores, regardless of species or domesticated status, are all feeding on the same foods or in the same environments. Actually, the most marked trait of the Havnø isotopic sample is its homogeneity.

Excepting the dog, all isotope values dated to the Neolithic at Havnø are extremely similar. Included in this homogeneity are swine, all dating to the Neolithic, and all exhibiting extensive overlap in isotopic values with the terrestrial herbivores. This is particularly notable because Mesolithic wild boar from Zealand also analyzed in this study do not show overlap, and in fact show enrichment, probably due to their omnivorous dietary tendencies (Genov 1981; Chapter 8). The lack of enrichment in the Neolithic sample at Havnø is probably indicative of the swine being domestic, as the unavailability of animal foods (such as invertebrates) to wild boar or a marked natural change in feeding behavior of wild boar is extremely unlikely. With human control of the diet of these animals, omnivory could, and probably was, completely curtailed resulting in the observed overlap. Further discussions of this are found in Chapter 8.

Discussion and Conclusions

The faunal material from Havnø presents examples of nearly all major problems encountered by zooarchaeologists when analyzing Stone Age sites of late Mesolithic or early Neolithic age. Numerous complications present themselves in understanding this assemblage, but not all are limiting in the sense that they present interpretation. The overall impression of the Havnø material is that it is highly diverse, fragmented, ambiguous, and interesting.

The Havnø fauna is interesting in several ways. First, in conjunction with previously published data, at least 16 species of mammal were recovered, although these included five species of rodent that are probably not archaeological. In addition, one species of amphibian was also recovered. Three and perhaps four species of domesticated animal are among the material but in terms of diversity, Havnø is truly outstanding in the number of bird species present. Including those species identified by Herluf Winge (Madsen et al. 1900), in all there are 34 species of bird at the site, a truly outstanding number. Additionally, fish from at least 13 families were recovered (Robson et al. in prep). So, in all, at least 64 individual species of all classes are confidently present among the material, with only few of them probably not archaeological. Not only are the species numbers diverse, but so are the resources they represent.

From the numbers and types of species alone, much can be said about the locality. From the land were hunted large terrestrial game, including red deer, roe deer, aurochs, elk, and probably wild boar. Trapping of terrestrial fur animals was also undertaken, but not to any great extent. Sea mammals, particularly seals, were hunted, either on shore when the hauled-out, or from boats while they swam. Also, a great variety of birds were hunted but in particular swans and velvet scoters were targeted. Notwithstanding all the other fauna, mollusks such as oysters were extracted at a large scale from the nearby fjord. The same is true of the fish that were targeted, the majority of which were European eels. At some point, perhaps replacing these activities, or perhaps supplementing them, domesticated animals started to become part of the local economy. Unfortunately, it is unclear to what degree hunting, gathering, or collecting of wild resources continued, but in all probability active animal husbandry was occurring very near to the island.

The body-part representation data indicate that when pooled, the large mammals are represented by nearly all parts of the body. This could either indicate that the animals were killed nearby and butchered at the site, or it could mean that all parts of the body were transported to Havnø after butchery. Depending on the time of year, this may also indicate transport by boat or sledge. Age data are somewhat limited in their interpretive value primarily due to the fact that the particular species in question are ambiguous, and the two possible options are wild and domestic respectively. Given the possibilities of seasonal husbandry of pigs and cattle, it is best to not interpret these data further in a seasonal sense, aside from mentioning that there are a number of young pigs, and calves. If wild, these species were both living and breeding on the island, or the young were being killed elsewhere and transported to the island. If domestic, however, these young individuals show active husbandry near to Havnø, and not short Neolithic visits given the unlikelihood of transporting a pregnant domestic animal to the coast for the purposes of a hunting foray. Ultimately, the only good data concerning seasonality come from the oysters themselves and migratory birds, the majority of which point to winter activities at the site, although this assessment is not to be taken as concrete. With the transition to agriculture, dog isotopes indicate a shift from a predominantly marine-based diet to a predominantly terrestrial-food based diet, a pattern also observed in the humans from the site (Harry Robson personal communication).

In conclusion, the highly diverse animal material from Havnø is indicative of a long human relationship with the coast. This relationship starts with a reliance on multiple wild resources, and later incorporates domestic species at the same location. Given the numbers and traits of the domesticates, this means that instead of simple short-term visits to the coast by Neolithic groups to obtain wild resources, animal husbandry is more likely occurring locally. This in turn means that the site was probably not a catching site, but in fact may have been residential during the Neolithic. When the stratigraphic issues are clarified, the picture will be more complete, but the fact remains that the stone age inhabitants of the Havnø island who accumulated its shell midden surely were able and capable of obtaining and using all resources available locally, including the domesticates that would arrive with the Funnel Beaker Culture.

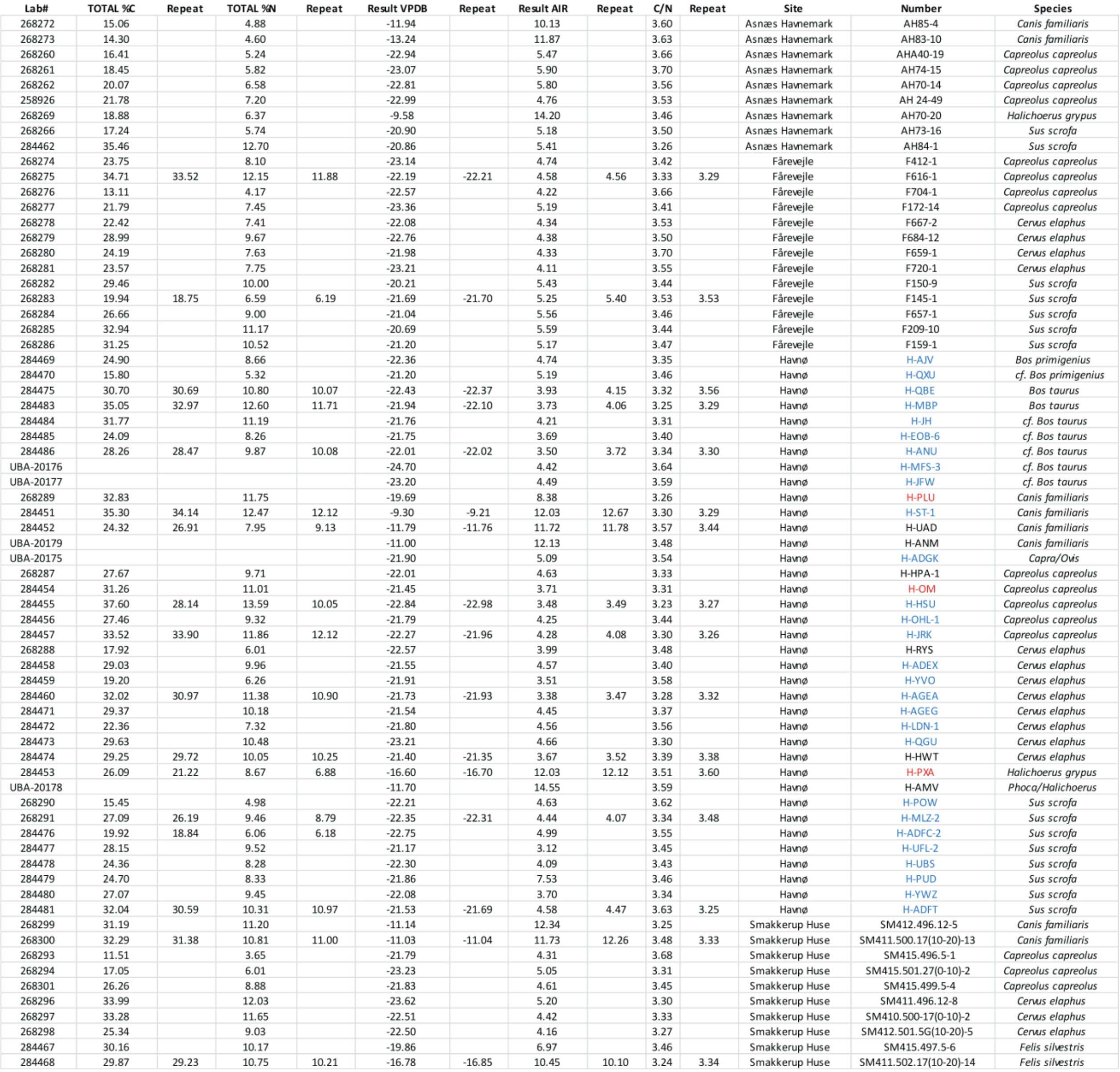
Chapter 8: Stable Isotopes

Introduction

Isotopic analyses were undertaken on subfossil animal bone from several sites in northwest Zealand, and from the kitchen midden at Havnø, on Jutland. Ninety-five samples were submitted for carbon ($\delta^{13}C$ VPDB) and nitrogen ($\delta^{15}N$ AIR) isotopic analyses from five sites, Asnæs Havnemark, Fårevejle, Havnø, Trustrup, and Smakkerup Huse. In addition, six samples were submitted for AMS ^{14}C dating and carbon and nitrogen ratio analysis. One of these did not yield sufficient collagen for both analyses and therefore is omitted in this discussion. In all, 69 isotopic samples yielded sufficient collagen and fell within acceptable ranges of atomic C/N ratios for bone preservation indicating a low likelihood of diagenesis (White et al. 2001). These data are listed in Table 8.1. All samples (N=13) submitted from Trustrup fell outside the acceptable range, in many cases also showed impossible values (e.g. deer showing high enrichment similar to that expected of marine carnivores), and were therefore discarded. Most other unacceptable values from the remaining sites did not fall significantly outside of the acceptable range. However, in order to be conservative, these values were discarded nonetheless.

Given the failure of the Trustrup analyses, the sample from northwest Zealand was bolstered by samples taken from the archaeological collection from Smakkerup Huse, a site for which some isotopic data and a monograph have been published and a location very near to the other sites analyzed here (Price and Gebauer 2005). In all, the useable material analyzed from Zealand included 32 samples (Asnæs Havnemark=9, Fårevejle=13, and Smakkerup Huse=10), all of which can be considered to be of middle and late Ertebølle in date. Thirty-seven samples were analyzed from the shell midden at Havnø, 28 of which are probably or definitely early Neolithic in date (AMS dated or based on stratigraphy), and 6 which are late Ertebølle (AMS dated or based on stratigraphy). This falls among the largest samples of wild and domestic carbon and nitrogen isotopic analyses from a single early Neolithic context in

Denmark. In the case of repeated measurements, due to the similarity between the repeats and the original measurements only the original results are discussed.



Lab#	TOTAL %C	Repeat	TOTAL %N	Repeat	Result VPDB	Repeat	Result AIR	Repeat	C/N	Repeat	Site	Number	Species
268272	15.06		4.88		-11.94		10.13		3.60		Asnæs Havnemark	AH85-4	*Canis familiaris*
268273	14.30		4.60		-13.24		11.87		3.63		Asnæs Havnemark	AH83-10	*Canis familiaris*
268260	16.41		5.24		-22.94		5.47		3.66		Asnæs Havnemark	AHA40-19	*Capreolus capreolus*
268261	18.45		5.82		-23.07		5.90		3.70		Asnæs Havnemark	AH74-15	*Capreolus capreolus*
268262	20.07		6.58		-22.81		5.80		3.56		Asnæs Havnemark	AH70-14	*Capreolus capreolus*
258926	21.78		7.20		-22.99		4.76		3.53		Asnæs Havnemark	AH 24-49	*Capreolus capreolus*
268269	18.88		6.37		-9.58		14.20		3.46		Asnæs Havnemark	AH70-20	*Halichoerus grypus*
268266	17.24		5.74		-20.90		5.18		3.50		Asnæs Havnemark	AH73-16	*Sus scrofa*
284462	35.46		12.70		-20.86		5.41		3.26		Asnæs Havnemark	AH84-1	*Sus scrofa*
268274	23.75		8.10		-23.14		4.74		3.42		Fårevejle	F412-1	*Capreolus capreolus*
268275	34.71	33.52	12.15	11.88	-22.19	-22.21	4.58	4.56	3.33	3.29	Fårevejle	F616-1	*Capreolus capreolus*
268276	13.11		4.17		-22.57		4.22		3.66		Fårevejle	F704-1	*Capreolus capreolus*
268277	21.79		7.45		-23.36		5.19		3.41		Fårevejle	F172-14	*Capreolus capreolus*
268278	22.42		7.41		-22.08		4.34		3.53		Fårevejle	F667-2	*Cervus elaphus*
268279	28.99		9.67		-22.76		4.38		3.50		Fårevejle	F684-12	*Cervus elaphus*
268280	24.19		7.63		-21.98		4.33		3.70		Fårevejle	F659-1	*Cervus elaphus*
268281	23.57		7.75		-23.21		4.11		3.55		Fårevejle	F720-1	*Cervus elaphus*
268282	29.46		10.00		-20.21		5.43		3.44		Fårevejle	F150-9	*Sus scrofa*
268283	19.94	18.75	6.59	6.19	-21.69	-21.70	5.25	5.40	3.53	3.53	Fårevejle	F145-1	*Sus scrofa*
268284	26.66		9.00		-21.04		5.56		3.46		Fårevejle	F657-1	*Sus scrofa*
268285	32.94		11.17		-20.69		5.59		3.44		Fårevejle	F209-10	*Sus scrofa*
268286	31.25		10.52		-21.20		5.17		3.47		Fårevejle	F159-1	*Sus scrofa*
284469	24.90		8.66		-22.36		4.74		3.35		Havnø	H-AJV	*Bos primigenius*
284470	15.80		5.32		-21.20		5.19		3.46		Havnø	H-QXU	*cf. Bos primigenius*
284475	30.70	30.69	10.80	10.07	-22.43	-22.37	3.93	4.15	3.32	3.56	Havnø	H-QBE	*Bos taurus*
284483	35.05	32.97	12.60	11.71	-21.94	-22.10	3.73	4.06	3.25	3.29	Havnø	H-MBP	*Bos taurus*
284484	31.77		11.19		-21.76		4.21		3.31		Havnø	H-JH	*cf. Bos taurus*
284485	24.09		8.26		-21.75		3.69		3.40		Havnø	H-EOB-6	*cf. Bos taurus*
284486	28.26	28.47	9.87	10.08	-22.01	-22.02	3.50	3.72	3.34	3.30	Havnø	H-ANU	*cf. Bos taurus*
UBA-20176					-24.70		4.42		3.64		Havnø	H-MFS-3	*cf. Bos taurus*
UBA-20177					-23.20		4.49		3.59		Havnø	H-JFW	*cf. Bos taurus*
268289	32.83		11.75		-19.69		8.38		3.26		Havnø	H-PLU	*Canis familiaris*
284451	35.30	34.14	12.47	12.12	-9.30	-9.21	12.03	12.67	3.30	3.29	Havnø	H-ST-1	*Canis familiaris*
284452	24.32	26.91	7.95	9.13	-11.79	-11.76	11.72	11.78	3.57	3.44	Havnø	H-UAD	*Canis familiaris*
UBA-20179					-11.00		12.13		3.48		Havnø	H-ANM	*Canis familiaris*
UBA-20175					-21.90		5.09		3.54		Havnø	H-ADGK	*Capra/Ovis*
268287	27.67		9.71		-22.01		4.63		3.33		Havnø	H-HPA-1	*Capreolus capreolus*
284454	31.26		11.01		-21.45		3.71		3.31		Havnø	H-OM	*Capreolus capreolus*
284455	37.60	28.14	13.59	10.05	-22.84	-22.98	3.48	3.49	3.23	3.27	Havnø	H-HSU	*Capreolus capreolus*
284456	27.46		9.32		-21.79		4.25		3.44		Havnø	H-OHL-1	*Capreolus capreolus*
284457	33.52	33.90	11.86	12.12	-22.27	-21.96	4.28	4.08	3.30	3.26	Havnø	H-JRK	*Capreolus capreolus*
268288	17.92		6.01		-22.57		3.99		3.48		Havnø	H-RYS	*Cervus elaphus*
284458	29.03		9.96		-21.55		4.57		3.40		Havnø	H-ADEX	*Cervus elaphus*
284459	19.20		6.26		-21.91		3.51		3.58		Havnø	H-YVO	*Cervus elaphus*
284460	32.02	30.97	11.38	10.90	-21.73	-21.93	3.38	3.47	3.28	3.32	Havnø	H-AGEA	*Cervus elaphus*
284471	29.37		10.18		-21.54		4.45		3.37		Havnø	H-AGEG	*Cervus elaphus*
284472	22.36		7.32		-21.80		4.56		3.56		Havnø	H-LDN-1	*Cervus elaphus*
284473	29.63		10.48		-23.21		4.66		3.30		Havnø	H-QGU	*Cervus elaphus*
284474	29.25	29.72	10.05	10.25	-21.40	-21.35	3.67	3.52	3.39	3.38	Havnø	H-HWT	*Cervus elaphus*
284453	26.09	21.22	8.67	6.88	-16.60	-16.70	12.03	12.12	3.51	3.60	Havnø	H-PXA	*Halichoerus grypus*
UBA-20178					-11.70		14.55		3.59		Havnø	H-AMV	*Phoca/Halichoerus*
268290	15.45		4.98		-22.21		4.63		3.62		Havnø	H-POW	*Sus scrofa*
268291	27.09	26.19	9.46	8.79	-22.35	-22.31	4.44	4.07	3.34	3.48	Havnø	H-MLZ-2	*Sus scrofa*
284476	19.92	18.84	6.06	6.18	-22.75		4.99		3.55		Havnø	H-ADFC-2	*Sus scrofa*
284477	28.15		9.52		-21.17		3.12		3.45		Havnø	H-UFL-2	*Sus scrofa*
284478	24.36		8.28		-22.30		4.09		3.43		Havnø	H-UBS	*Sus scrofa*
284479	24.70		8.33		-21.86		7.53		3.46		Havnø	H-PUD	*Sus scrofa*
284480	27.07		9.45		-22.08		3.70		3.34		Havnø	H-YWZ	*Sus scrofa*
284481	32.04	30.59	10.31	10.97	-21.53	-21.69	4.58	4.47	3.63	3.25	Havnø	H-ADFT	*Sus scrofa*
268299	31.19		11.20		-11.14		12.34		3.25		Smakkerup Huse	SM412.496.12-5	*Canis familiaris*
268300	32.29	31.38	10.81	11.00	-11.03	-11.04	11.73	12.26	3.48	3.33	Smakkerup Huse	SM411.500.17(10-20)-13	*Canis familiaris*
268293	11.51		3.65		-21.79		4.31		3.68		Smakkerup Huse	SM415.496.5-1	*Capreolus capreolus*
268294	17.05		6.01		-23.23		5.05		3.31		Smakkerup Huse	SM415.501.27(0-10)-2	*Capreolus capreolus*
268301	26.26		8.88		-21.83		4.61		3.45		Smakkerup Huse	SM415.499.5-4	*Capreolus capreolus*
268296	33.99		12.03		-23.62		5.20		3.30		Smakkerup Huse	SM411.496.12-8	*Cervus elaphus*
268297	33.28		11.65		-22.51		4.42		3.33		Smakkerup Huse	SM410.500-17(0-10)-2	*Cervus elaphus*
268298	25.34		9.03		-22.50		4.16		3.27		Smakkerup Huse	SM412.501.5G(10-20)-5	*Cervus elaphus*
284467	30.16		10.17		-19.86		6.97		3.46		Smakkerup Huse	SM415.497.5-6	*Felis silvestris*
284468	29.87	29.23	10.75	10.21	-16.78	-16.85	10.45	10.10	3.24	3.34	Smakkerup Huse	SM411.502.17(10-20)-14	*Felis silvestris*

Table 8.1: Acceptable isotopic data indicating a low likelihood of digenesis (blue=Neolithic, black=Mesolithic, red=uncertain age)

In this chapter, carbon and nitrogen isotopic rations from Havnø and those from northwest Zealand are compared and some observations are made. However, Havnø and northwest Zealand are separated by approximately 100 km and, therefore, the geographic separation warrants a discussion.

Geographic variation in available atmospheric carbon has the potential to affect resultant values obtained from archaeological samples of the same species from different localities and indeed does (van Klinken et al. 1994). However, this variation across northern Europe is quite small even though differences of over one part per million are observed on a larger European continental scale. More specifically, variation due to differences in atmospheric carbon in bone isotopic ratios between Sweden and the Netherlands showed on average only a difference of 0.1‰ and variation between Sweden and Poland was only 0.2‰, values far smaller than those observed within samples of the same taxa from the region of northwest Zealand, and, indeed, within the observed range of variation from individual sites (see below; van Klinken et al. 1994). These distances are much larger than those separating the sample locations in this study. Therefore, it is appropriate to compare carbon isotope samples from the locations under consideration here as expected geographic variation is at best a fifth of a part per million, a variation much smaller than observed variability within this sample from individual sites.

Nitrogen isotopic ratios depend on the degree of nitrogen cycling through an ecosystem, or how quickly and to what degree nitrogen is processed through organisms within that ecosystem (Tykot 2004). As ecosystems are complex, the ratio between the stable isotopes of nitrogen depend ultimately on a number of factors, including aridity, rainfall, climate, habitat disturbance, trophic level and all influences affecting the degree and intensity of nitrogen cycling (reviewed in Drucker et al. 2003). Sometimes these processes can be quite local (Drucker et al. 2003). However, the sources of the variation in nitrogen cycling are either too large-scale to register major differences in climate and rainfall over a distance of 100km or are indicative of variation in local situations such as fires and forest clearance which even minor geographic distances would not affect. In other words, the opportunity for the small-scale factors to act on nitrogen fixation in organisms is just as likely to act on herbivores living 100km from each other as it is on herbivores living in one of the most heterogeneous Mesolithic environments in Denmark, northwest Zealand (Paludan-Müller 1978). On the other hand, the separation is not enough to have widely divergent rainfall patterns, for example (Heaton et al. 1986; Paludan-Müller 1978). Overall, geographic separation under consideration here is probably not a major influencing factor on the carbon and nitrogen isotopic values of terrestrial species for the abovementioned reasons. Further, where geographic variation is to be expected, among the marine mammals, it is dealt with accordingly below (Craig et al. 2006; Tykot 2004).

Several major findings follow the data obtained. First, early domesticates at Havnø appear to be eating the same protein sources as contemporary wild animals. These domesticates were living within the same environments, and/or being fed with the same foods as wild animals. This could mean that the wild animals were living in an environment already opened up by early Neolithic anthropogenic forest clearance or opened up by an expansion of coastal grasslands and other open areas predicated by a fall in sea level. Second, swine at Havnø are eating protein from similar sources as both wild deer as well as domestic cattle at Havnø, and this is markedly different than the divergent diets of Mesolithic wild boar and wild deer. This could mean that; 1)the swine at Havnø are domestic animals, are eating the same foods as cattle, and are unable to obtain typical omnivorous foods or 2)that wild boar from Havnø are living in the same restricted environment as the other species, wild and domestic, have limited access to their normal omnivorous dietary supplements, and have a diet that reflects these factors. The more likely explanation in this case is that the swine tested are most likely domestic species, and if this is the case, then the carbon and nitrogen isotopic ratios of uncertainly wild or domestic wild boar can be used in conjunction with those known from wild animals to determine whether or not individuals are domestic. Third, isotopic evidence from dogs at Havnø indicates a major shift in diet about the transition to agriculture at the site. This is some of the first evidence from an individual transitional site of such a shift and is in agreement with other published information about transitional diets in the region (Fischer et al. 2007). At Havnø, diets of domestic dogs, and therefore probably their human counterparts experienced a major shift, from almost entirely marine protein sources to almost entirely terrestrial protein sources with the arrival of agriculture.

Overall, the isotopic data presented here establishes a baseline range for Mesolithic species on a regional level, enabling comparisons between sites and understanding of the local variation in diets of wild animals. Importantly, this range of variation demonstrates that in an area of high potential environmental variability, the overall range of variation in wild animals is similar to that at single sites, or across southern Scandinavia. This establishes a probable maximum range outside of which real difference can be expected. Further, the first comprehensive analyses of an early Neolithic faunal community are established and show a much different situation than expected based on previous research. Ultimately, these analyses present data useful for understanding early husbandry and hunting practices just after the transition to agriculture in Denmark.

Results: Mesolithic Sample from Zealand and Havnø

The Mesolithic carbon and nitrogen isotopic ratio sample from three sites in northwest Zealand consists of terrestrial and marine fauna, including one grey seal, nine wild boar, seven red deer, eleven roe deer, two wildcats, and five domestic dogs. These samples give an outstanding picture of the late Ertebølle isotopic variability in the area The Mesolithic sample from Havnø is much smaller than the Neolithic sample from Havnø as well as the Mesolithic sample from Zealand, in part due to the Havnø material being buried deeper in the midden and therefore crushed more and unsuitable for analyses. The Mesolithic sample from the midden consists of two dogs, one roe deer, two red deer and one seal of uncertain species. Two of these specimens were directly AMS radiocarbon dated, and both fell into the latter half of the Ertebølle culture. The other Mesolithic samples not directly dated are assigned a Mesolithic date based on stratigraphic placement within the midden. Data from the Mesolithic sample as a whole is listed in Figure 8.1, with samples from Zealand and Havnø grouped. In sum, 38 isotopic measurements are shown, all best assigned to the late Mesolithic Ertebølle culture.

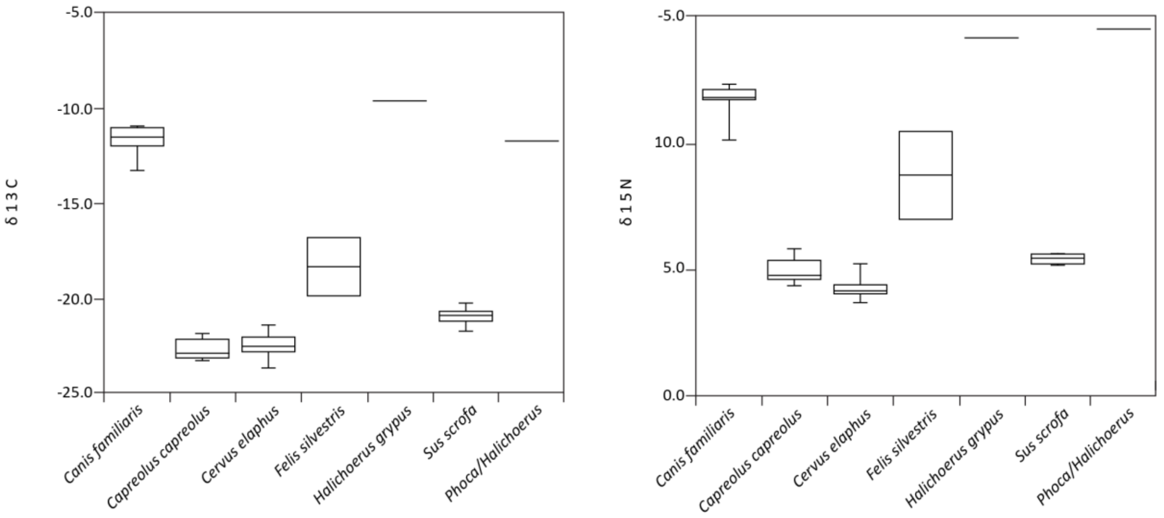


Figure 8.1: Stable isotopic ratios of carbon and nitrogen from Mesolithic contexts

Results: Neolithic Sample from Havnø

All results from Havnø, excepting several specimens discussed above, are Neolithic in age or likely Neolithic based on stratigraphic placement within the shell-heap. The Neolithic sample from Havnø consists of 28 isotopic measurements which among their number include three directly AMS dated specimens; two cattle and one ovicaprid. These results can be seen in Figure 8.2.

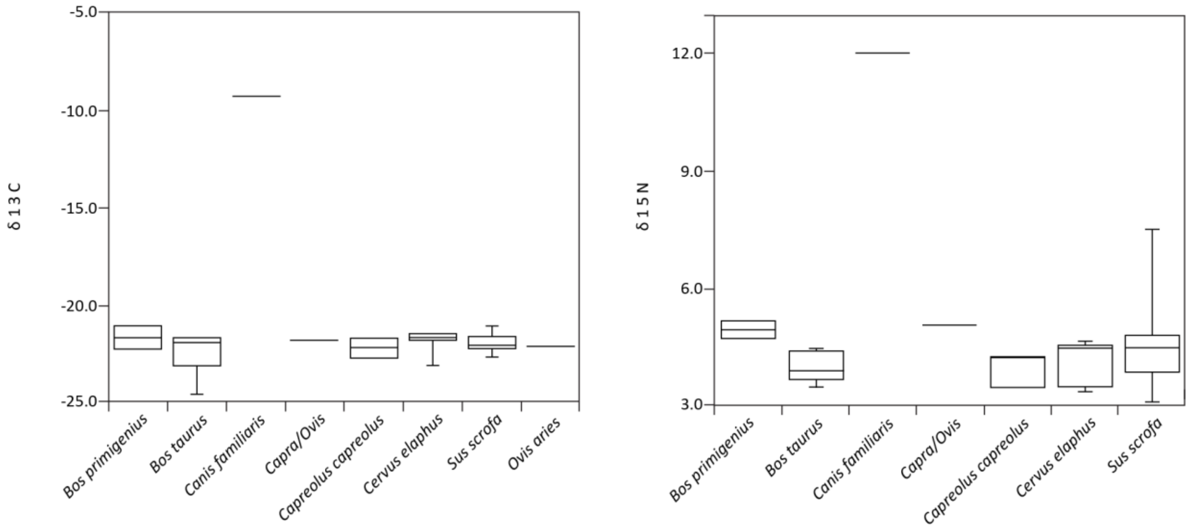


Figure 8.2: Stable isotopic ratios of carbon and nitrogen from Neolithic materials from Havnø

One sample, MFV, a sheep, was dated to the ENI, but the isotopic data was discarded due to very low yields notwithstanding the utility of the date. Domestic, wild, and unsure specimens were analyzed, including domestic cattle, sheep and goats, wild or domestic pigs, and some other samples in small numbers. Six red deer, three roe deer, eight wild boar or domestic pig, two aurochs, seven domestic cattle, one ovicaprid, and one domestic dog are Neolithic in age, and based on the four AMS dates among this material, date to the latter half of the ENI.

Seals

The three seals analyzed warrant a special discussion. Two isotopic values were obtained from Havnø, one of certain Ertebølle date (Chapter 2) and the other of uncertain date. The Ertebølle seal showed highly marine $\delta^{13}C$ and $\delta^{15}N$ values (-11.7‰ and 14.5‰5 respectively) while the grey seal of uncertain age showed $\delta^{13}C$ and $\delta^{15}N$ values of -16.6‰ and 12.12‰ respectively). One Ertebølle grey seal was analyzed from Asnæs Havnemark and had $\delta^{13}C$ and $\delta^{15}N$ values of -9.58‰ and 14.20‰. There is a high degree of variation in the seal isotope values, the multiple reasons for which have been discussed elsewhere (Craig et al. 2006). The variation observed in this sample (>5‰ in $\delta^{13}C$) is ultimately probably due to a gradient resulting from terrestrial freshwater input into the Baltic causing more negative values in Baltic waters as opposed to the purely marine values expected from the North Sea and Atlantic Ocean (Craig et al. 2006). The result is that marine species living in the Baltic have more negative $\delta^{13}C$ values than those living in, for example, the North Sea (Craig et al. 2006). Therefore, the sample consists of two seals that were eating the majority of their foods in open ocean, probably the North Sea or Atlantic Ocean, and one seal that was living at least part of its life in more closed Baltic waters. The seals showing less negative values probably were taken during wide-ranging seasonal migration. The more negative seal of unknown age cannot be taken to reflect a change in the marine environment, but instead the possibility that the individual in question either lived most of its life in the Baltic or other closed waters and was taken during a seasonal migration, or was hunted by wide-ranging EBK or TRB hunters. In this case, it was most likely killed during a seasonal migration.

Dogs

Eight domestic dog specimens were analyzed for carbon and nitrogen isotopic ratios. Four dogs were from Zealand, two each from Smakkerup Huse and Asnæs Havnemark and all dating to the late Ertebølle culture. In addition, four dogs were analyzed from Havnø, one stratigraphically dated to the early Neolithic, one of uncertain age, one stratigraphically dated to the late Ertebølle, and one dog directly AMS dated to the late Ertebølle (Chapter 2). The four EBK dogs from Zealand all exhibit very enriched carbon and nitrogen isotope values, exhibiting borderline complete or nearly completely marine protein in the diet for both metrics (see Fischer et al. 2007). The four dogs from Havnø show a more complicated picture. One dog of unknown cultural age yielded $\delta^{13}C$ and $\delta^{15}N$ values of -19.69‰ and 8.38‰. These values are predominantly terrestrial, and this animal was eating far less marine foods than its counterparts from Zealand . Based on past patterns of dog, and therefore human diets, this dog might best be assigned to the early Neolithic based on these highly negative values although, of course, this animal could date to the EBK. The other three values from Havnø are highly marine, falling between $\delta^{13}C$ values of -9.3‰ and -11.79‰ and $\delta^{15}N$ values between 11.73‰ and 12.13‰. These values reflect protein sources that are almost entirely, or entirely marine. As two of these values are late Ertebølle in date, one directly dated, these two dogs, and presumably the corresponding human inhabitants of Havnø, were obtaining most, if not all, of their protein from marine sources. Of particular interest, however, is that one of these values, specimen "ST", is stratigraphically placed as being Neolithic in age. There are two possible explanations for this. First, that a Neolithic individual from Havnø was continuing a Mesolithic pattern of protein intake, a situation not unheard-of for Denmark, as evidenced by the Neolithic man from Rødhals (Fischer et al. 2007). On the other hand, this specimen could have simply been from a disturbed context, although most finds within the midden are in situ.

Swine

In total, seven wild boar from Fårevejle and Asnæs Havnemark dating to the late Ertebølle and eight swine (either domestic or wild pig) from the early Neolithic at Havnø were isotopically tested. The Mesolithic wild boar δ^{13}C and δ^{15}N values ranged from -20.21‰ to -21.69‰ and 5.17‰ to 5.59‰ respectively. The Neolithic swine δ^{13}C and δ^{15}N values ranged from -21.17 to -22.75 and 3.12 to 7.53. With few exceptions, there is little overlap between the two samples, with the Mesolithic sample showing enrichment that the Neolithic sample does not show as a whole. The shift is seen in Figure 8.3.

Within the Mesolithic sample of carbon values, the wild boar show some enrichment over the red deer and roe deer. This is due to slight trophic-level enrichment due to the omnivorous tendencies of wild boar, a pattern seen elsewhere in Stone Age Scandinavia (Noe-Nygaard 1995). Omnivorous wild boar also occasionally eat other animals, such as carrion or other food sources including small prey and invertebrates (Genov 1981; Richter and Noe-Nygaard 2003). The Neolithic sample does not show this enrichment due to omnivory, and swine values exhibit significant overlap with contemporary Neolithic wild species from Havnø as well as with domestic cattle at the site. Similar to the trophic enrichment in the carbon values, on average nitrogen enrichment is just over one part per million, indicating that while the Mesolithic boar are eating a mixed omnivorous diet, it is not, in aggregate, more than a rather small part made up of animal prey as enrichment is at most a third of a trophic level of nitrogen enrichment (Bocherens and Drucker 2003).

Within the Neolithic sample of swine, values are less enriched, with the entire sample showing little overlap with few exceptions with the Mesolithic sample. In carbon values, the entire Neolithic sample shows nearly a complete shift on average to more negative values with the data shifting around a part per million towards less enrichment. Among the nitrogen values, a similar shift also is seen. One Neolithic outlier, however, exhibited the highest nitrogen values of any of the swine tested by far, with a value of 7.53‰ but retained an average carbon value typical of its other Neolithic counterparts. The reasons for this one outlier are not clear.

The most parsimonious explanation for the observed shift from the Mesolithic to the Neolithic is that the Neolithic individuals are, in fact, domestic pigs and are no longer eating an omnivorous diet. If these swine were wild, then their dietary shift is expected to be similar to the wild deer. In this case, that would mean that, in concert with the wild herbivores and if maintaining an omnivorous diet, the Neolithic wild boar from Havnø would be expected to show an approximately one part per million shift towards *more* enrichment. However, the shift is towards *less* enrichment by the same margin. So, if these samples are wild, then they are not omnivorous at all or to an extremely low degree, an explanation that does not hold much weight as this would require a significant behavioral shift on the part of wild boar, or a major disruption in the availability of small prey items. Neither of these is a likely scenario. If the swine are domestic; however, the lack of ominivory is more easily explained as they are simply being fed the same foods as the domestic cattle, sheep, and goats. Therefore, the Neolithic swine from Havnø are almost certainly domestic pigs. This dietary shift from wild to domestic could prove useful in differentiating wild from domestic forms, especially given the difficulties separating the two in the earliest Neolithic (see Enghoff 2011; Chapter 7).

Wild Terrestrial Herbivores

Several species of wild herbivore were analyzed for this project including red deer, roe deer, and aurochs, the results of which are shown in Figure 8.3. Twelve EBK roe deer, three TRB roe deer, and one roe deer of uncertain age were analyzed while nine EBK and six TRB red deer were analyzed. Two TRB aurochs were also analyzed. Mesolithic roe deer carbon and nitrogen values ranged from -23.36‰ to -21.79‰ and 4.22‰ to 5.9‰ respectively. Mesolithic red deer carbon and nitrogen values ranged from from -23.62‰ to -21.4‰ and 3.6‰ to 5.2‰. Neolithic carbon and nitrogen values from roe deer ranged from -22.84‰ to -21.79‰ and 3.48‰ to 4.28‰ and for red deer the values ranged from -23.21‰ to -

21.54‰ and 3.38‰ to 4.66‰. Two Neolithic wild aurochs yielded carbon values of -22.36‰ and -21.2‰ and nitrogen values of 4.74‰ and 5.19‰. Between the Mesolithic and Neolithic samples, the roe deer show enrichment, on average, of around one part per million in δ^{13}C values. Their δ^{15}N values also show enrichment of around one part per million. Average red deer values show a similar enrichment shift of around two-thirds of a part per million in δ^{13}C values and enrichment of around a third of a part per million. However, in the case of the nitrogen values, the overall range of values and small sample size indicates that in all reality, little shift is evident among the sample. The aurochs date to only the Neolithic, and while a good indicator of the diet of a forest-dwelling herbivore, due to the lack of a Mesolithic sample, they are included here simply to bolster the overall herbivore sample, and are not interpreted further due to extensive overlap with the other terrestrial Neolithic herbivores.

Red deer and roe deer are both obligate herbivores, and therefore do not eat anything other than plant foods. Therefore, the possibility for trophic level enrichment causing observed increases in carbon isotope ratio values between the Mesolithic and Neolithic samples can be discounted. Within each terrestrial herbivore species sampled here, observed average enrichment is likely due to a more open environment in which the individual species are obtaining their diets. Considering the carbon isotope data alone, roe deer show a higher increase than the red deer between the Mesolithic and the Neolithic periods.

Nitrogen values obtained for these species are somewhat more difficult to interpret, as there is no clear and immediate environmental correlate for observed variation in nitrogen isotope values of plants in environments of the type present at the transition in southern Scandinavia (Drucker et al. 2003). Further, there is considerable, if not complete overlap in the range of observed values between the Mesolithic and Neolithic samples. Even though average observed enrichment between the two samples was nearly a part per million in the roe deer, assigning meaning to this is difficult due to the large amount of overlap among the values. With nitrogen values of terrestrial herbivores, a major influencing factor is the possibility of increasing environmental aridity causing enrichment (Heaton et al. 1986). However, in this case, enrichment is rather low, as is variation, and the values therefore cannot be used to comment on any such potential changes (Heaton et al. 1986). An increase in nitrogen cycling due to a number of factors may also cause enrichment in nitrogen isotope values, and such increase can be due to fertilization, fires, cultivation, and a number of other factors (Drucker et al. 2003). However, on a realistic level, none of these factors can be used to explain any shifts due to the rather low degree of observable average shifts among the nitrogen values, as well as the low overall variation. In other words, the nitrogen isotope values from red deer and roe deer over the transition, in this case, cannot be assigned meaning.

Wildcats

Two wildcats from Mesolithic contexts at Smakkerup Huse were analyzed to establish a terrestrial carnivorous ceiling for isotopic values in this study. The two individuals recovered at the EBK site Smakkerup Huse showed widely divergent values, with carbon values of -19.86‰ and -16.78‰ and nitrogen values of 6.97‰ and 10.47‰. This places the less enriched wildcat just under two parts per million less negative than the most enriched terrestrial herbivore in carbon values and just over one part per million less negative in nitrogen values. As trophic level enrichment is approximately 0-2‰ for δ^{13}C and 3-5‰ for δ^{15}N, this indicates that the wildcats were eating terrestrial prey, usually rodents (Bocherens and Drucker 2003). However, the more enriched wildcat has carbon and nitrogen values over three parts per million more than its counterpart, an interesting degree of variability in diet between two individuals found at the same locality. The more enriched wildcat has carbon isotope ratios of -16.98‰, a value that sits almost five parts per million higher than the highest terrestrial herbivore and three parts per million higher than its counterpart. Similarly, in nitrogen values its enrichment sits at 10.45‰, over four parts per million higher than the nearest terrestrial herbivore. This cat is extremely enriched.

There are several possible explanations for this observed variation among the two cats and their terrestrial herbivore counterparts. The first explanation would be trophic level enrichment, which explains the less enriched individual's relationship with the values from the terrestrial herbivores. In fact, this individual falls where we should expect it to given a full trophic level of enrichment over basal consumers. The other wildcat's values however, are probably not best explained by trophic level enrichment, as that individual's values would require that it were an apex predator, subsisting only on other predators. This is an extremely unlikely situation for an animal the size of a wildcat.

Unfortunately, wildcats are no longer extant in Denmark, a fact that disallows reporting of their true, wild diets in the region (Aaris-Sørensen 2009). Further, the vast majority of extant populations which may be studied across Europe exhibit extensive interbreeding with domestic cats, and are not entirely pure wildcats (Macdonald et al. 2010). Some of these populations are best described as part-wildcat hybrid populations. Reviewing extant populations, nevertheless, wildcats are best described as facultative predators, preferring rabbits to rodents, then rodents if rabbits are not available, and then invertebrates and reptiles if neither rabbits nor rodents are available (Lozano et al. 2006). Rabbits were not present on Zealand during the EBK (Aaris-Sørensen 2009). Therefore, wildcat diet was probably based on rodents, and possibly some invertebrates and reptiles. Little or no marine foods or waterfowl are consumed by wildcats today (Lozano et al. 2006).

The less enriched wildcat clearly is subsisting on this sort of diet. On the other hand, the more enriched individual is probably eating other, less common foods for a wildcat, perhaps containing input from the marine environment. However, some other explanatory possibilities may exist. For example, if one ignores the fact that the analyzed tibia had a completely fused distal epiphysis which indicates adulthood and suppose that this animal was not yet weaned, this would explain the elevated nitrogen values. However, this would not explain the elevated carbon values. Ultimately, the enriched individual must have been eating a very significant proportion of its diet from the sea, and it may not be completely out-of-bounds to suggest a possible relationship with humans, as modern wildcats do not eat seafood.

However, the nitrogen values of the more enriched individual are also elevated to a large degree, which may suggest a degree of further trophic enrichment, at least in a proportion of its diet, indicating possible dietary flexibility not observed in modern wildcat populations. Further, there are no known coastal wildcat populations today, a fact that precludes us from precisely knowing whether or not coastal wildcats may have consumed foods from the sea naturally. One other big caveat is the lack of comparable isotopic data for both reptiles and invertebrates. As these values are unknown, they could also be responsible for the enrichment in both carbon and nitrogen of the more enriched cat. Ultimately, reasons for the disparity between the two are still enigmatic. It is probably best not to over-interpret these values, as while predator carbon and nitrogen isotope values are rare from the Mesolithic, in particular the EBK, among those that are published, there do appear to be rather broad ranges. An example of this would be the otters described by Fischer et al. (2007).

Discussion

In Figure 8.3, the Mesolithic carbon and nitrogen isotopic ratios from the purely wild sample are shown in comparison with wild deer, swine, wild cattle, and domestic cattle from the Neolithic layers at the midden at Havnø. Havnø represents an excellent opportunity to understand diets of early cattle at a single location, and in conjunction with other dietary information concerning Mesolithic and Neolithic wild species, presents an unprecedented opportunity to understand early husbandry at the coast during the TRB. While the sample is small, results indicate a lack of difference between the diets of wild herbivores and domestic cattle in both the recorded carbon and nitrogen isotopic ratios. On average, the two major terrestrial herbivores, roe deer and red deer have carbon isotope values which demonstrate significant overlap with domestic cattle and swine (Figure 8.3). A similar situation is observed in the nitrogen values, in which again, the average cattle values are in fact slightly lower than those of the two deer species with a very large degree of overlap (Figure 8.3).

The Mesolithic carbon sample exhibits marked overlap in the diets of roe deer and red deer due to the species foraging in similar environments. Their nitrogen ratios are somewhat divergent, probably due to their consumption of a range of specific foods within the similar environments. As is discussed above, wild boar are somewhat enriched in carbon ratios relative to these two species, and this is probably due to its omnivorous dietary preferences in stark contrast to the wholly herbivorous nature of the two deer species. The separation between the pigs and other wild species is less pronounced in the nitrogen sample from the wild species, although on average the wild boars are still enriched relative to their wild deer counterparts. The trends concerning the nitrogen values of the terrestrial herbivores show a homogenization of diet between the Mesolithic and Neolithic, in which the Neolithic deer show overlap in their diets while in the Mesolithic the roe deer are somewhat enriched relative to the red deer. In the Mesolithic, this difference is probably due to variable foods being consumed within the same environment. Therefore, the Neolithic overlap could possibly be attributed to a homogenization of the environment in which fewer foods are available, a scenario in agreement with the herbivores from Havnø eating in open, coastal grassland.

The maximum range of variation within all values from the Mesolithic isotope sample is within two parts per million. As environmental variation is thought to have been high in the study region during the Atlantic period (Paludan-Müller 1978), and in conjunction with the several Mesolithic samples from Havnø, variation observed among the isotopic ratios of terrestrial wild species within this region from several sites likely approximates the maximum variation that can be expected within what is today Denmark. Further, values from any of the Mesolithic sites exhibit extensive overlap with each other, indicating that this range of variation is not an aggregate of several tightly clustered unique populations, but can be considered as a pool and as a whole is indicative of the isotopic dietary picture of these species. This also means that comparisons of wild and domestic species must rely on contemporary individuals taken from the same location, as observable shifts have the potential to be obscured in the normal range of variation in aggregate samples if that is all that is available.

The diets of cattle, wild deer, and aurochs have been previously studied to understand the diets of early domestic cattle in southern Scandinavia (Noe-Nygaard et al. 2005; Noe-Nygaard and Hede 2006).

Noe-Nygaard and her colleagues tested the carbon and nitrogen isotopic ratios of 26 early Neolithic cattle from across Denmark, including several specimens from the shell midden at Visborg, very near to Havnø. However, most specimens were from Zealand and were then compared to wild fauna from the Åmose in order to conclude that there was little or no overlap in isotopic ratios between the earliest Neolithic cattle and their wild counterparts. This was used to argue against common feeding locations and practices for wild and domestic types (Noe-Nygaard et al. 2005). In other words, they argue from the outset that cattle are clearly being kept outside of the forest environments inhabited by their wild counterparts, and are probably living and grazing in coastal grasslands, not being leaf-foddered.

Leaf foddering, or the feeding of livestock with branches and leaves of trees and bushes, has been supposed to have been one of the early Neolithic strategies for feeding early domestic cattle in southern Scandinavia (Rasmussen 1989). In part, this was proposed in conjunction with pollen data concerning the elm decline, with feeding of livestock causing the precipitous decline of the tree species roughly coincident with, and subsequent to, the arrival of agriculture. Arguments for leaf-foddering have suffered significantly from the lack of firm archaeological evidence of the practice, and the focus on a single species for fodder has largely been disproven (Noe-Nygaard et al. 2005). However, environmental implications aside, it is an interesting question as to how early Neolithic livestock were fed in terms of human behavior both on a broad scale, as well as a more local level. Because no firm archaeological evidence of husbandry practices has emerged from Denmark proper, it is only accessible through other lines of evidence, including pollen, and, important to this discussion, stable isotopes.

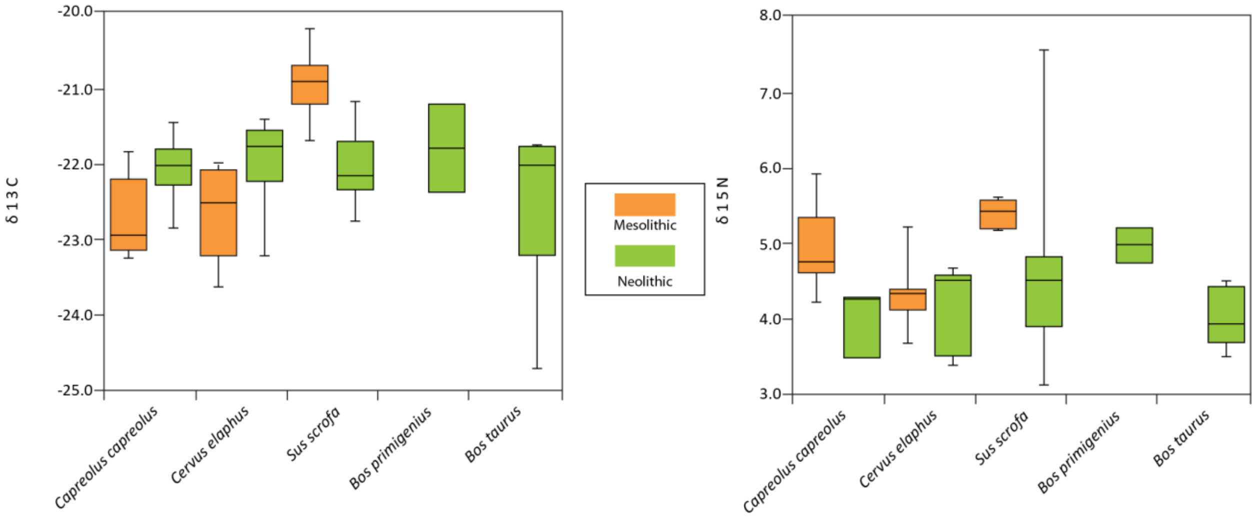


Figure 8.3: Stable isotopic ratios of carbon and nitrogen from the Mesolithic and Neolithic

The observed enrichment of the Neolithic deer, and complete overlap of the Neolithic deer and their domestic counterparts at Havnø can be explained by looking again to data presented by Nanna Noe-Nygaard and her colleagues (2005). In conjunction with their data, two trends become immediately clear. First, the carbon isotopic values on domestic cattle from Havnø overlap extensively with other published early Neolithic cattle from southern Scandinavia, and second, deer values from Havnø are more enriched than those from the Åmose (Noe-Nygaard et al. 2005; Noe-Nygaard 1995). Therefore, it is unlikely that observed dietary overlap at Havnø between wild and domestic species is due to a specific feeding strategy in which cattle and other domesticates are being purposefully fed either in the forest or leaf-foddered. If this were the case, the values for the Havnø cattle should approximate those of the Mesolithic deer sample obtained here as well as published deer data from the Åmose (Noe-Nygaard 1995). In this case, the anomaly is that the Havnø Neolithic deer are eating in a more open environment than their counterparts on Zealand. The conclusion is that the deer hunted during the early Neolithic at Havnø were probably previously living in an environment already being cleared for agriculture, or significantly altered by sea level change, an environment already being used by people for domesticate husbandry. Therefore, by the latter half of the earliest Neolithic, there was an earlier marked human impact upon the landscape or a marked change in the landscape around the shell midden at Havnø predicated by a change in sea level.

In general, the recording of marked coastal environmental changes at Havnø does not appreciably disagree with the findings of Noe-Nygaard et al. (2005) and, in fact, supports and complements their conclusions in several important ways. Their observed differences between the diets of early Neolithic domestic cattle and their wild terrestrial herbivore counterparts were taken to mean that from the very outset of agricultural cattle husbandry, cows were living in more open environments, such as grassland and herb-covered environments. This contrasting view of feeding of early Neolithic species partially stems from the fact that the wild data cited (Noe-Nygaard et al. 2005) were drawn from an earlier study of the inland Åmose basin (Noe-Nygaard 1995) and that the Neolithic (and Mesolithic) wild red deer were living at an inland locality, while the cattle were drawn from a number of locations, many of which were coastal or near coastal. The Havnø sample of wild species from the Neolithic, however, is entirely coastal and shows extensive overlap with the domestic species.

With regards to Noe-Nygaard's (1995) sample of deer from the Åmose, the coastal Mesolithic sample from northwest Zealand obtained here does show extensive overlap with those data, indicating that while not identical, their environments were similar at that time. So, the resulting picture is one of Mesolithic deer all living and eating in similar environments, Neolithic cattle all eating and living in rather more open environments, early Neolithic deer from the Åmose continuing to eat what they did in the Mesolithic, and coastal deer from the Neolithic shifting their diet to more open environments, similar to those of the cattle. The only two changes are, therefore, the appearance of cattle that all seem to be living in the same types of environments and the change in the diets of coastal wild deer populations to more open environments. These results are consistent with the supposition by Noe-Nygaard and Hede (2006) that marine foreland areas, opened up by a marine regression around the time of the introduction of agriculture were more available for cattle husbandry and in this case, it appears that these areas were also inhabited by wild herbivores as well.

One of the most interesting findings is the shift towards less enrichment in the swine between the Mesolithic sample and the Neolithic sample, the effect of which is very similar isotopic values between contemporary wild deer and swine in the Neolithic. While somewhat less clear in the nitrogen sample where on average Neolithic swine are around one part per million less enriched than their Mesolithic counterparts, the carbon isotope data show a similar trend towards less enrichment. Coupled with the opening-up of the environments in which the deer were living, the swine show a reduction in their eating of ominivorous foods relative to their contemporaries. The net result is that the swine are both living in nearly the same environments as their counterparts, as well as eating the same foods. This is not a natural situation for a wild boar, as their diet almost always contains at least some animal foods (Genov 1981). The Mesolithic roe deer are eating foods that cycle nitrogen somewhat faster than the red deer, an unsurprising result given their preference for edge habitats over the preferred closed forest habitats of red deer (Richter and Noe-Nygaard 2003). At Havnø, and perhaps a local effect, the two deer species are living in an environment cycling nitrogen at a similar rate, but so are the pigs. However, if wild, the Neolithic swine should still be partially ominivorous given that their preferred animal foods should still be available and reflected in both the carbon and nitrogen isotopic ratios. They are not. As this is a highly atypical situation, this may indicate that the Neolithic swine are, in fact, domestic animals being fed, and prevented from ominivory.

Conclusions

The Mesolithic isotopic sample from northwest Zealand and Havnø, as well as the Neolithic isotopic sample from Havnø elaborate upon previous studies in the region by providing a regional view of coastal animal feeding strategies about the transition, as well has human diets with the arrival of agriculture. Dog data convincingly show that a major dietary shift from marine to terrestrial protein dietary sources occurs at Havnø as is typical elsewhere in southern Scandinavia (Fischer et al. 2007). The wild herbivores experience a change in their environment at the coast with the arrival of agriculture, with feeding occurring more often in more open environments concurrent with the arrival of domesticates, probably as the result of environmental changes in these near-sea areas. This is in contrast with wild animals from the interior, which seem to retain much of their previous feeding patterns in environments that were probably more closed (Noe-Nygaard 1995). The homogeneity of feeding environments of the domesticates and wild herbivores at Havnø, in conjunction with the sheer number of domesticates at the site, seems to indicate that the cattle are living most of their lives in open areas near the coast. Further, swine at Havnø that date to the early Neolithic show dietary patterns dissimilar to the Mesolithic, and this may indicate that some, if not many of them may be domestic. Taken together, this probably means that shell-midden settlements such as Havnø may not have been satellite localities for the seasonal procurement of wild resources as has been previously proposed, but in fact can best be considered truly Neolithic settlements contributing to the early farming economies of southern Scandinavia. In this regard, and particularly when the isotopic data are considered along with the domestic animal faunal data from Havnø (Chapter 7), calling Havnø a Neolithic “catching site” is a misnomer (see Johansen 2006).

Chapter 9: Mesolithic Synthesis

Introduction

As presented in Chapter 1, a primary goal of this project is to define variability in EBK faunal assemblages and build a model of EBK faunal use against which other assemblages, particularly those from the earliest Neolithic, can be compared. This approach relied on new data from a number of sites in a restricted area of Denmark which were excavated by the same researcher using the same methodology in an effort to minimize biases in the sampling. This sample is meant to be comparable more broadly as well. Therefore, comparisons and model-building will occur on three levels. First, the discussion will consider the EBK assemblages from Asnæs Havnemark, Fårevejle, Trustrup, and the previously reported site of Smakkerup Huse (Price and Gebauer 2005). The purpose of these comparisons is to illustrate EBK resource use in the restricted area of northwest Zealand, and present an exhaustive regional picture of the EBK economy in an area of high reported resource and environmental variability (Paludan-Müller 1978).

Second, comparisons will be expanded to include all of the appropriately comparable published sites from the island of Zealand. The purpose of these comparisons is to understand how variable resource use is across the island of Zealand, an area of similar faunal availability. Third, all of the EBK culture area will be considered, elaborating upon the applicability of comparisons over such a large area and similarities and differences across the region. This variability will be used to create a general model of resource use against which future data can be assessed. As previous data are reviewed earlier in this dissertation (Chapter 2), sites will be mentioned by name and non-numerical data will not be repeated unless appropriate. The subsequent chapter will address Neolithic sites from this same region.

Northwest Zealand

Fragmentation

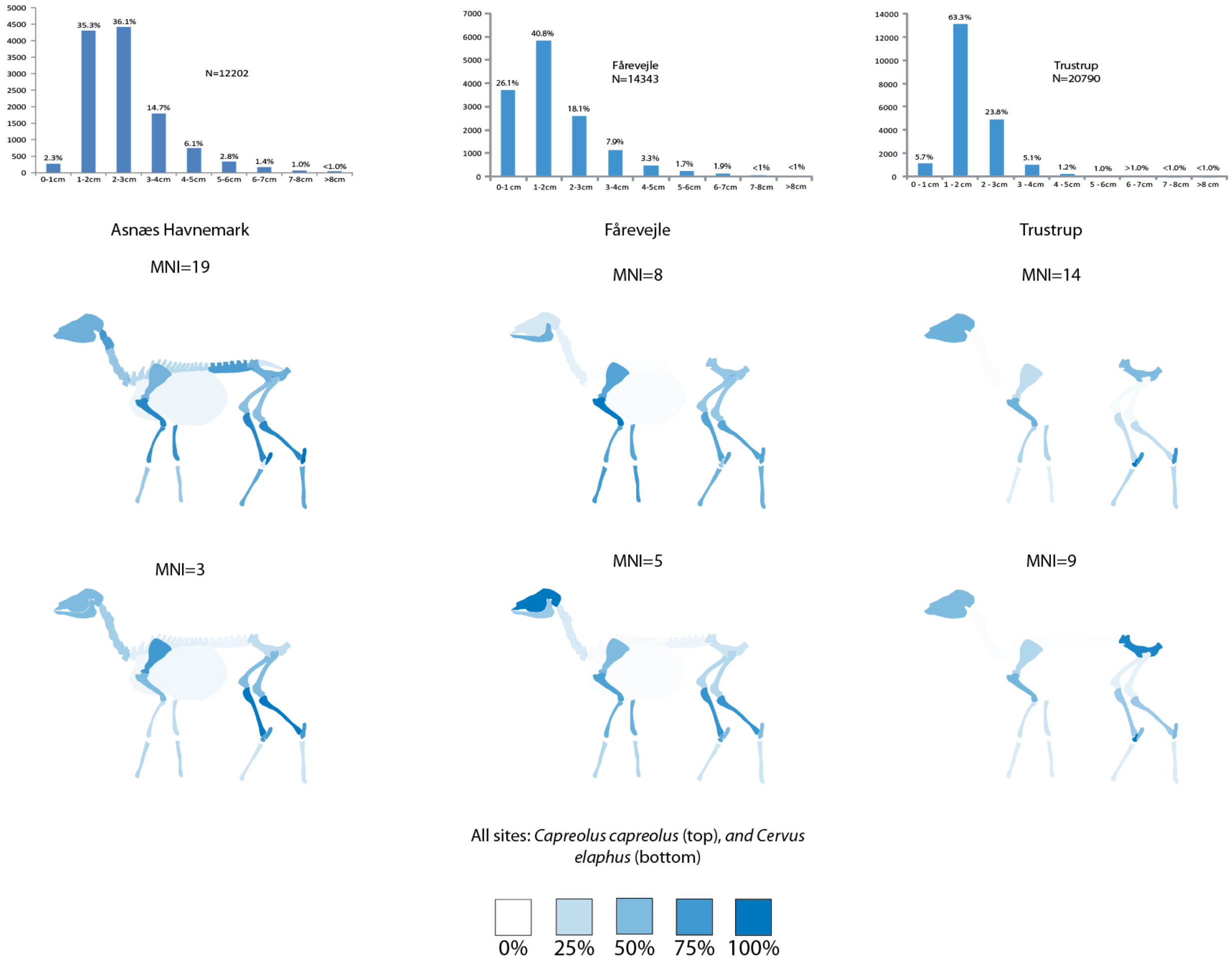
Prior to a discussion of various factors and data pertaining to the study sites, a mention of the comparative degree of fragmentation of the northwestern Zealand faunal assemblages is germane. Overall fragmentation data were obtained for the entirety of the Asnaes Havnemark, Fårevejle, and

Trustrup assemblages by measuring each recovered bone, complete or not, on one centimeter graph paper (Chapter 3). The results are displayed in Figure 9.1. Unfortunately, similar data are not available for Smakkerup Huse as measurements of this type were not taken (Signe Hede, personal communication). With subsequent handling and sampling of the assemblage, and the potential for some material to be missing (particularly from unidentifiable materials) in extant collections from the site, taking such measurements at this time has the potential to be unreliable or biased. It is therefore not included.

Of the three assemblages that were assessable, Asnæs Havnemark is the least fragmented, with over 20% of the material over three centimeters in overall length. Fårevejle is the next most fragmented assemblage, with just over 14% of the material over three centimeters in length. Trustrup is the most fragmented of the three, with less than 10% of the material greater than three centimeters in length. Trustrup actually has a higher proportion of materials that are in the 2-3 cm size class than Fårevejle and fewer materials that are of 0-1 cm in maximum length. However, in terms of overall extent of fragmentation pertaining to identifiability and utility in determining the past economy of the sites, the larger fragments are more often useful. This means that while Trustrup has a higher proportion of larger, 2-3cm fragments, it has far fewer fragments larger than that, and therefore can be considered to be the most fragmented. Overall however, the assemblages from Trustrup and Fårevejle are similar in their degree of fragmentation, both much more broken-up than the bones from Asnæs Havnemark.

These fragmentation data are also interesting in light of the proportion of the materials that are determinable to species relative to the entire assemblage sample size. Size is obviously not the only factor determining identifiability in faunal remains. For example, a tooth fragment from a wild boar with dimensions well under one centimeter can confidently be identified as such when coming from Mesolithic contexts, while a much larger fragment of longbone is often required to identify the same taxon based on postcranial elements. However, as all three of these sites from northwest Zealand are dominated by red deer, roe deer, and wild boar, such a comparison may hold some weight. Taking all classes of fauna (mammals, birds, and amphibians) identified to species or class of species together, 18.62% of the Asnæs

Havnemark assemblage was identified to species, 8.93% of the Fårevejle assemblage was similarly identified, and only 5.98% of the Trustrup assemblage was able to be determined. In this sense, the Asnæs Havnemark assemblage has far more utility for determining the past activities of EBK hunters than the other two, which have more similar albeit still somewhat different degrees of fragmentation. However, for the above reasons, the Fårevejle assemblage can be considered to have been nominally less fragmented, and better preserved in general than that Trustrup assemblage.



All sites: *Capreolus capreolus* (top), *and Cervus elaphus* (bottom)

Figure 9.1: Maximum length of all bones recovered from three EBK sites in conjunction with %MAU

Number of Species

For the purposes of the following standardized comparative discussion which incorportates data from the literature and this dissertation, small mammals such as rodents are not included as archaeological, except for beavers, hedgehogs, and red squirrels (see individual site chapters for justification). Further, numbers of species are considered here to be minimum numbers of species, as oftentimes taxa are grouped, or not separable. In the case of grouped species, only a single species is considered to be present unless multiple taxa have been confidently identified. Finally, domestic species are present at several of these sites, but for the purposes of documenting Mesolithic variability, regardless of date, these species, including the domestic dog, are omitted.

Asnæs Havnemark yielded 12 species of wild mammal, including terrestrial mammals, sea mammals, and semi-aquatic mammals. Fårevejle yielded eight species of mammal, including terrestrial and sea mammals. The number of species at Trustrup, omitting domesticates, is nine. Smakkerup Huse yielded 12 species of mammal, including terrestrial mammals as well as marine mammals and fur species (Price and Gebauer 2005). So, in terms of wild domestic game, the number of species present at EBK sites in Northwest Zealand ranges from 8 species to 12 species.

The numbers of bird species are highly variable among the assemblages. Thirteen species of bird were recovered at Asnæs Havnemark, while at least six species were recovered at Fårevejle. Excavations at Trustrup yielded no identifiable species of bird, though some remains were clearly of avian species and therefore, at least one species of bird was present at Trustrup. Smakkerup Huse yielded five species of bird (Price and Gebauer 2005). Variable numbers of species of birds probably have little economic meaning in these contexts, owing to the differing conditions of bone preservation encountered at the three sites as well as with the fragile nature of bird bones. This is not to say that there probably are actual differences in the original use of birds at these EBK sites. For example, widely contrasting numbers of bird species were recovered at Havnø and Fårevejle. Other similarities between the sites will be discussed later in this chapter, but in reference to birds in particular, the two sites have virtually identical degrees of fragmentation (Chapter 5), but Havnø yielded 23 species of bird, while only six were confidently attributed at Fårevejle. In this case, real differences were observable. Unfortunately, within the northwestern Zealand sample, the number of bird species shows an inverse relationship to the overall degree of fragmentation, and, therefore, the true numbers are probably unknowable. In this case, taphonomic processes probably are obscuring the real quantities of birds that were deposited.

Amphibians from all sites were recovered in such small numbers that they probably are not archaeological, and their presence most likely has nothing to do with humans. Even if they were present due to human action, their role in the food economies would have been negligible, due to their extremely small numbers of never more than several specimens. Fårevejle had no species of amphibian, and Trustrup, Asnæs Havnemark, and Smakkerup Huse each had only one species of amphibian (Price and Gebauer 2005).

Types of Species

The types of species recovered from the Mesolithic contexts are also of paramount interest, as is the proportion of the faunal material of the individual classes of animal. In general, the taxa can be divided into classes that may describe more accurately what the species actually are being used for. Obviously, depending on the age, treatment, and other information recovered, the roles of these species can change dramatically. An example of this would be the skinned deer from Agernæs, which clearly were clearly not being hunted for food, but rather for their skins (Richter and Noe-Nygaard 2003). In most cases, this is situation-dependent, and evidence is discussed in those happenstances. However, for this study, the biggest and most important class of taxa is the big three, which included red deer, roe deer, and wild boar. Further, there is little evidence that these species, at the four sites in northwest Zealand, were being used for anything other than for subsistence, although the possibility cannot be excluded. For the purposes of this part of the discussion, however, they will be considered as a group, and as a major contributor to the human subsistence economy at the sites (Chapter 4).

The second class of animal is fur animal, consisting of pine marten, fox, wildcat, beaver, red squirrel, and otter. These species' primary use in Stone Age contexts was probably for their furs, with individuals elsewhere being hunted or trapped, skinned, and then sometimes deposited whole (Richter and Noe-Nygaard 2003; Rowley-Conwy 1994-1995; Trolle-Lassen 1986; 1987). Even though there is no evidence of such processing at the sites analyzed here, the presence of these species most likely can be attributed to these purposes as it is unlikely, albeit not impossible, that fur species were consumed or utilized in a largely different way than elsewhere.

A third class of species consists of simply one taxon, the domestic dog. While not technically a prey animal, owing to their presence in almost all of the assemblages domestic dogs were clearly of some importance. Their domestic status, their ability to be transported by or with humans, and their clear post-death use at several sites in question here warrants their inclusion in their own category. In many ways dogs were a tool, but there is also evidence of their role as a companion at Asnæs Havnemark, and as raw material for the manufacture of certain items.

A fourth category is the marine mammals. Marine mammals were either hunted from shore or from boats. Up to four species of seal and the harbour porpoise were present in Mesolithic Denmark. Of these seals, present in these assemblages are at least two species, the grey seal and at least one member of the genus *Phoca*, the ringed seal (*Phoca hispida*) (Price and Gebauer 2005). While it is unclear which other species are represented in the genus *Phoca*, the possibility exists that the harbour seal and harp seal may also be present in these assemblages as there are a number of indistinguishable individuals, grouped simply as "seals" (Aaris-Sørensen 2009). These species are grouped owing to the difficulties differentiating seals as well as probable or possible similarities in hunting strategies required to obtain mammals from the sea.

Found at these sites are three classes of birds which are separable based on differences in behavior, environments in which they live, and by presumable differences in use by EBK groups. The first are raptors, predatory birds including the osprey, white-tailed eagle, and golden eagle. These species may have been killed in order to obtain their feathers, perhaps for fletching (Clark 1948). The second are waterfowl, including the great auk, mute swan, red-throated loon, red-necked grebe (*Podiceps grisegena*), whooper swan, herring gull, red-breasted merganser, great crested grebe, ducks, goosander, common murre, and razorbill. These species probably were taken as food, using either nets or bows and arrows.

The third class is the passerines, or songbirds, the utility of which by EBK groups is questionable and somewhat enigmatic. However, they must have been of some, unknown use, as their presence is not explained easily in archaeological deposits otherwise.

The last class of species important to the economies of the sites is the fishes, which are discussed in a separate section below. Fishing was clearly an important, if not dominant part of the subsistence economies at most EBK settlements. Smaller rodents, as discussed in the individual site chapters, are not included in this discussion because they are neither archaeological, nor very rare, and probably not that important to the economies of the sites. Further, another species which is difficult to classify is the capercaillie, or wood grouse, a terrestrial species probably hunted differently than waterfowl. Extremely rare, it is only found at Smakkerup Huse (Price and Gebauer 2005). Therefore, it is not included in comparisons.

Ultimately the fauna recovered can be separated into eight classes of species, all of which can be considered to require different skills to acquire, are found in different environments, or are hunted at different times of year from each-other. The proportions of these types of species to one-another when recovered from archaeological contexts are the most useful measure by which the importance of activities at the sites are assessed. In addition, these proportions also indicate what types of economic activities were going on both on an individual site basis, as well as regionally.

Of the eight types of species, however, only a few can truly be contributory in any major way to the EBK faunal economy at the sites in question. In fact, all of these sites can be considered in a major part to have been hunting sites for the big three. The majority of recovered mammal bones at each site are over three-quarters of the assemblage, with Smakkerup Huse (93.6% big three), Fårevejle (96.2%), and Trustrup (92.7%) all above 90%. Only Asnæs Havnemark (78.4%) has any real appreciable numbers of other mammal species.

Relative Abundance-NISP/MNI

Relative abundance is the single measure most often used to understand differences between EBK and TRB faunal assemblages. Relative abundance of variable species is then used to infer the purpose or economic foci of sites (see Enghoff 2011, for example). Of course, there are some very significant influences on these comparative quantitative statistics. The fact remains, however, that there are different numbers of remains of different species in EBK assemblages. These variable numbers actually do mean something. Influencing factors here have been minimized to the best of my ability by including four assemblages all excavated by the same researcher, using the same methodologies. However, the overall picture of relative abundance varies little between NISP and MNI values, indicating that conclusions drawn separately from these measures are not affected to a great degree by factors such as recovery methodology and fragmentation. As seen in Figure 9.2, similarity is seen in relative abundance between both NISP and MNI values of taxa and therefore commentary concerning the relative abundance of species does not change appreciably between the two statistics.

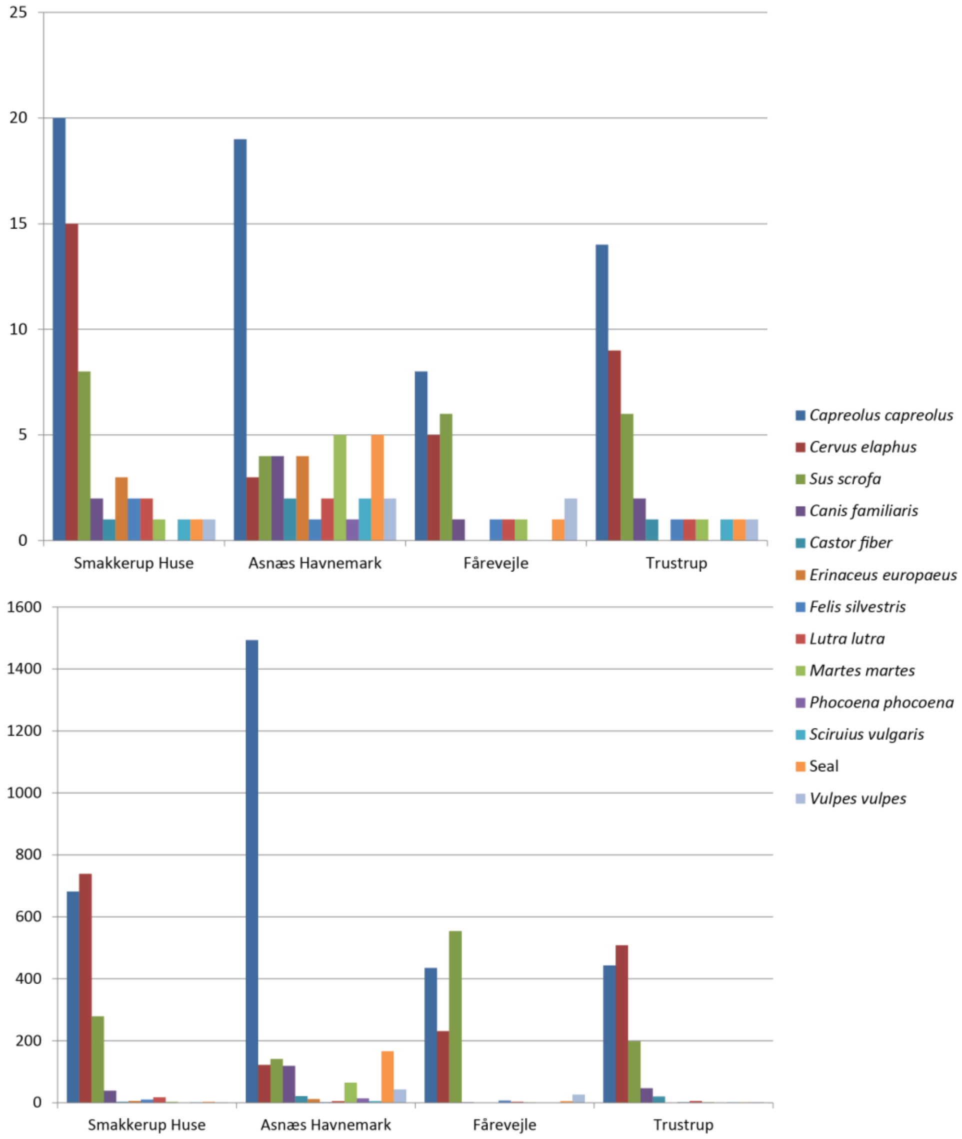


Figure 9.2: MNI (top) and NISP (bottom)

However, there are some minor observed differences concerning MNI versus NISP values. First, the best represented species, red deer, roe deer, and wild boar occasionally swap which is more abundant, but not to a great degree. An example of this is seen in the assemblages from Smakkerup Huse and Trustrup, where red deer are most abundant in terms of NISP but roe deer are the most abundant in terms of MNI. However, this does not greatly affect interpretations. Second, MNI values tend to inflate the abundance of rarer species, an effect observed here, but again not to a great degree (Payne 1985). This is because the less-common species are never a significant contributor to the economy of the sites in question. Regardless of statistic, the conclusions remain constant concerning relative abundance. Therefore the effects on these measures are negligible.

Age Structure

The age structure of animals that were ageable is similar to the seasonality data, skewed based on what was found and dependent on what was or was not excavated. For example, more precise ageing of specimens is not possible at Trustrup, but could be performed at Asnæs Havnemark and Fårevejle. While juveniles were reported in the Smakkerup Huse assemblage and used to establish seasonality of occupation (Price and Gebauer 2005), unfortunately the ages or age ranges of these specimens were not reported directly.

In all, 4.2% of the assemblage from Trustrup showed any signs of being juvenile (Chapter 3). At Fårevejle and Asnæs Havnemark, the percentages were 14.5% and 2.2% respectively. Of the three, Fårevejle had by far the highest proportion of bones that had evidence of being from juvenile animals. However, this measure is not exact, as it requires *appropriate* elements in some cases to determine the presence of a juvenile. An example would be unfused epiphyses. Further, not all types of animals have the same number of skeletal elements. Therefore these animals can be either over- or under-represented in counts such as these even if the same number of juvenile animals were present. An example of this would be the forefoot of a single juvenile red deer and a single juvenile pig, which has more separate metacarpal bones than the deer.

Perhaps a better measure of the age structure of species at these sites are specimens that can be assigned age more accurately by using side-by-side comparisons with specimens of known ontogenetic age, using both toothwear and body size and overall shape. At Asnæs Havnemark, 32 specimens were aged in this fashion, and at Fårevejle, 17 specimens were similarly assessed, all shown in Figure 9.3. This does not mean that 49 individuals are represented, because some of these specimens almost certainly come from the same individual. Nevertheless, the resulting age profiles show an age spread, but the comparative rarity of old individuals, ranging from what is probably a fetal roe deer specimen through prime individuals and several comparably old roe deer at Asnæs Havnemark. In short, there is little evidence of focused procurement of a specific age class, although the evidence may anecdotally indicate a slight preference or availability of younger animals of all species.

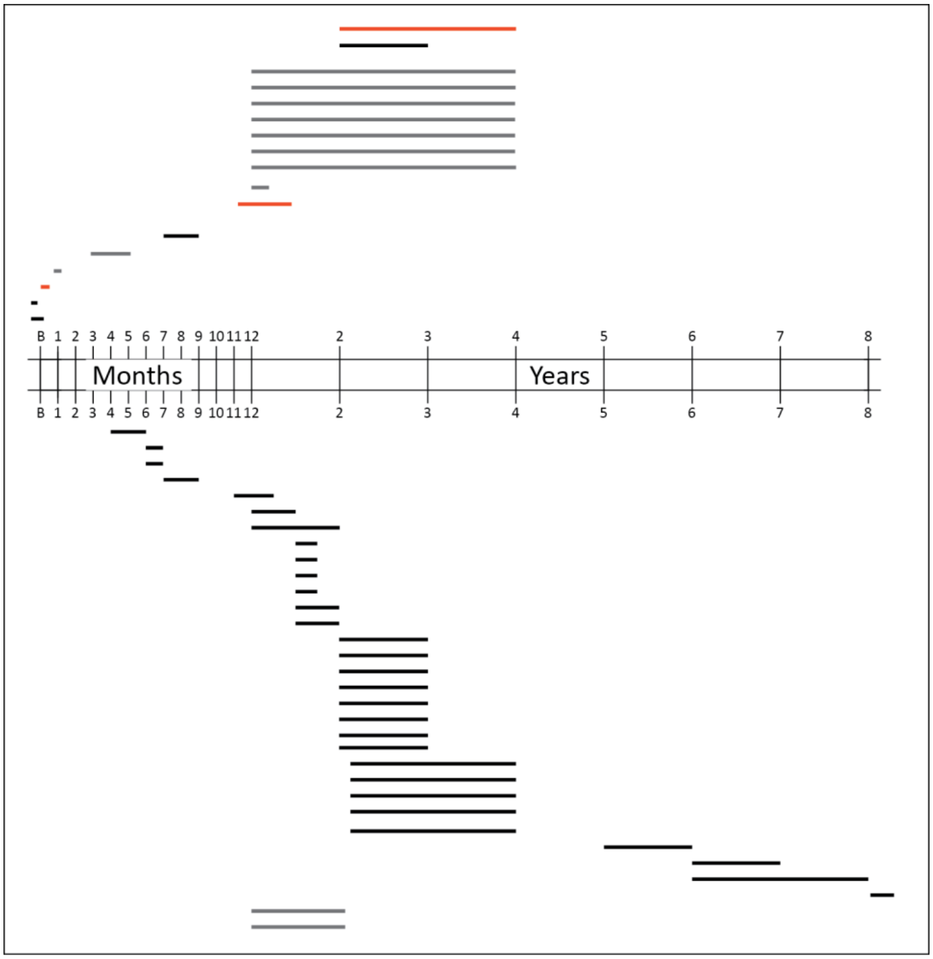


Figure 9.3: Aged specimens (Fårevejle on top, Asnæs Havnemark on bottom: black=*Capreolus*, grey=*Sus*, red=*Cervus*)

Based largely on incomplete data from these two sites, there is no overwhelming evidence of stressed populations of any of the big three, as such populations would be unnaturally skewed towards younger individuals. In most cases, high hunting pressure will result in a population containing more young individuals than are expected in a sustainably hunted natural population (Koike and Ohtaishi 1985, Steele 2003, Munro 2004). If such a pattern is seen, then this will indicate overhunted or stressed populations. In addition, when highly-ranked prey populations are stressed, resource breadth increases to include more lower-ranked species (Munro 2004). None of these trends are seen unequivocally in this sample, as all sites contain the big three in absolute dominant proportions and numbers. Therefore, evidence does not support overwhelmingly the notion that populations of the prime game animals in northwest Zealand were being overexploited during the late Mesolithic.

Body Size

The potential for comparing body-size among zooarchaeological samples is always limited by the specific parts of bones that are represented in an assemblage. In this case, comparisons also were limited by the degree of preservation, coupled by the fact that in any given mammal, each individual measurement can be taken twice, once for each side of the body. In this analysis, bilateral symmetry is ignored, meaning in all likelihood in some instances both the right and left pairs of specific elements from the same individual are recorded. The largest samples for comparing body-size among roe deer in northwest Zealand are the GLm of the astragalus (N=27, Figure 9.4), the Bd of the tibia (N=33, Figure 9.5), and the SLC of the scapulae (N=27, Figure 9.6) when measurements from all sites are combined. While the largest sample, the tibia measurements do not include any data from Trustrup and, therefore, the other two smaller samples also are included in this discussion.

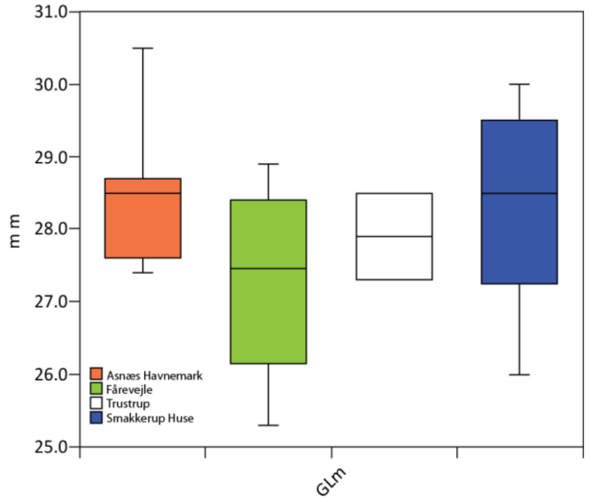


Figure 9.4: Roe deer astragalus GLm (N=27)

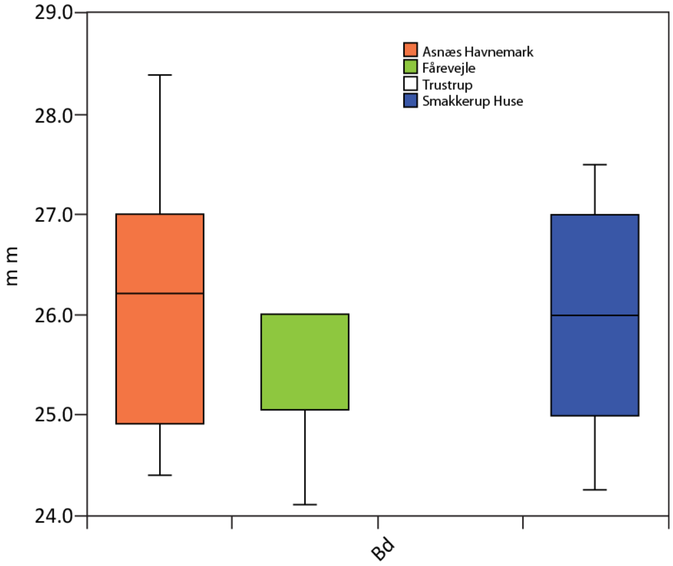


Figure 9.5: Roe deer tibia Bd (N=33)

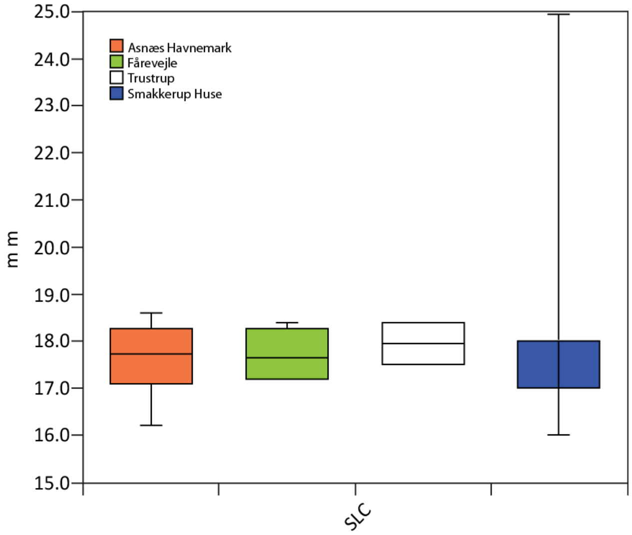


Figure 9.6: Roe deer scapula SLC (N=27)

Comparative measurements of roe deer based on these three comparisons show extensive overlap in body-size between all four sites. There are no significant differences in the ranges of variation evident in the measurements able to be taken. Therefore, there is no evidence that the roe deer hunted at these four sites came from separate populations or populations where groups of animals could not freely breed with each other. Animals of similar size were available in the region, regardless of where they were hunted.

Sample sizes of red deer are smaller and are given here for the GLl of the astragalus (N=18, Figure 9.7) and the Bd of the tibia (N=19, Figure 9.8). These smaller sample sizes are a direct function of the fewer individuals found at the sites. Unfortunately, while many other measurements were taken, numbers were smaller. I focus here on the largest available samples. The sample of wild boar was much too small to give a realistic impression of overall body-size in the region or to make strong conclusions. Therefore, it is not addressed.

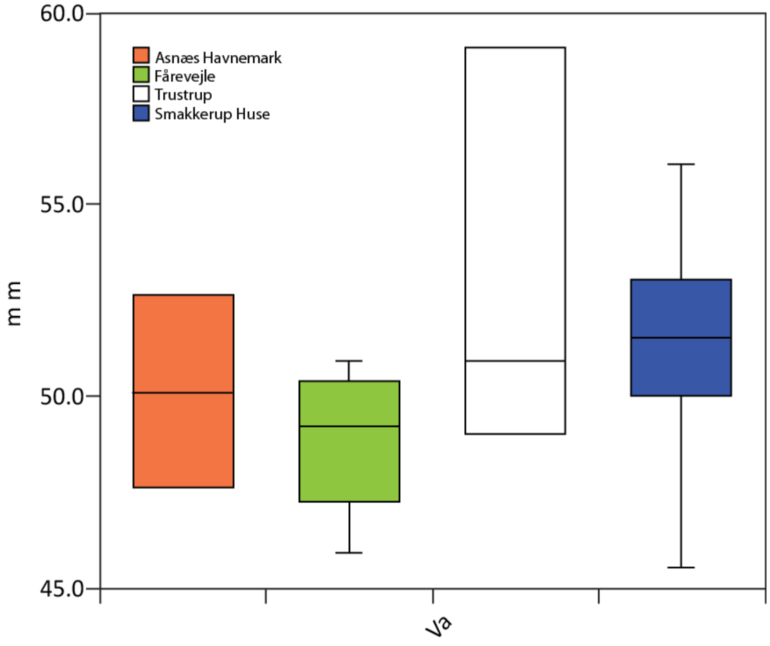


Figure 9.7: Red deer astragalus GLl (N=18)

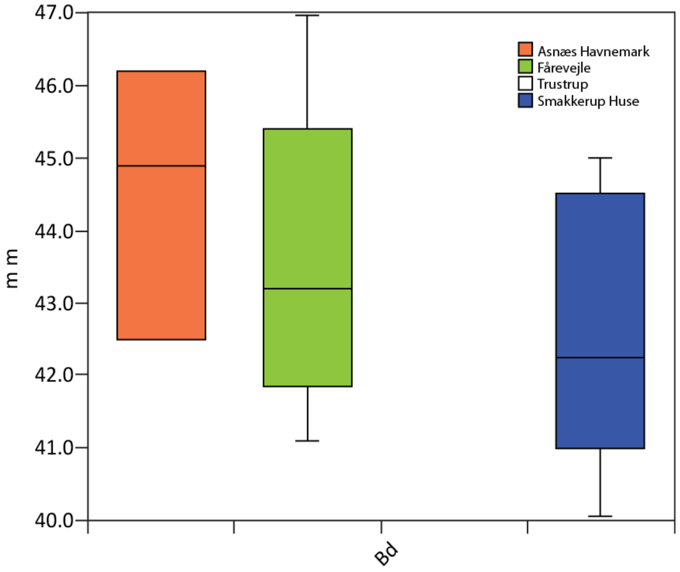


Figure 9.8: Red deer tibia Bd (N=19)

The red deer similarly show significant overlap in body-size measurements and body-size in northwest Zealand. The majority of the data are in both cases overlapping between all sites, indicating, as in the roe deer, that the animals were not hunted from isolated populations and that similar sized animals were available, regardless of the location of the site within the region. Along or near the coast in northwest Zealand, measurements hint at low variability in terms of body-size of prey, regardless of the type of site or the microenvironment of the site. In all likelihood this may indicate that hunters were not necessarily choosing locations for the hunting of the species with quality or size of potential prey as criteria.

Isotopic Variation/Environments

Isotopic investigations were undertaken to determine whether or not it is possible to differentiate environments from which the prey animals were taken or if there are patterns of differential procurement of these prey from specific localities. As discussed in Chapter 8, data from Smakkerup Huse had to be substituted in place of Trustrup for diagenetic reasons. Nevertheless, the picture is one of low variability. There is very extensive overlap between both carbon and nitrogen isotopic ratio values from the big three in northwest Zealand during the EBK (Figures 9.9, 9.10, 9.11, 9.12, 9.13, 9.14). Individually, none of the sites exhibit singular patterns of isotopic signals. That is, none of the sites shows a major deviation from the others with the one exception of the roe deer δ^{15}N values from Asnæs Havnemark (Figure 9.10) which show enrichment relative to the Smakkerup Huse and Fårevejle. The reasons for this are unclear and are discussed in Chapter 8. However, a sole deviation does not make a pattern, especially in consideration of considerable overlap between sites concerning the δ^{13}C values from roe deer and difficulties assigning causality of increased nitrogen cycling in plant foods being consumed by terrestrial herbivores. Therefore, the isotopic data are interpreted to show extensive overlap in this region, seemingly independent of any potential environmental differences between sites. In this sense, variability is low, and the feeding preferences and behavioral nature of the species in question appear to be dictating where they are eating and do not seem to indicate major differences in habitats between hunting sites.

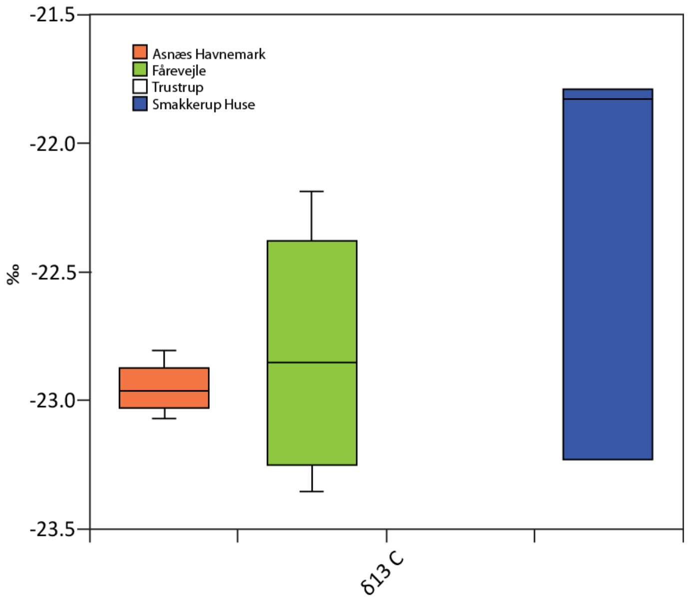


Figure 9.9: Roe deer δ^{13}C values in northwest Zealand (N=11)

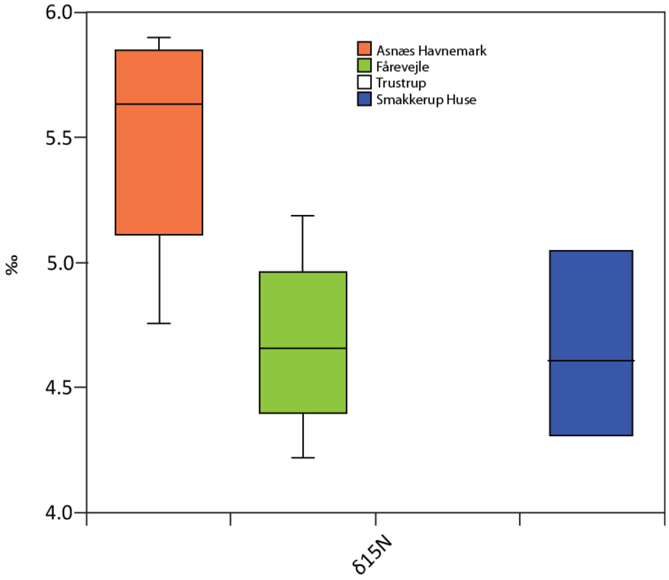


Figure 9.10: Roe deer δ^{15}N values in northwest Zealand (N=11)

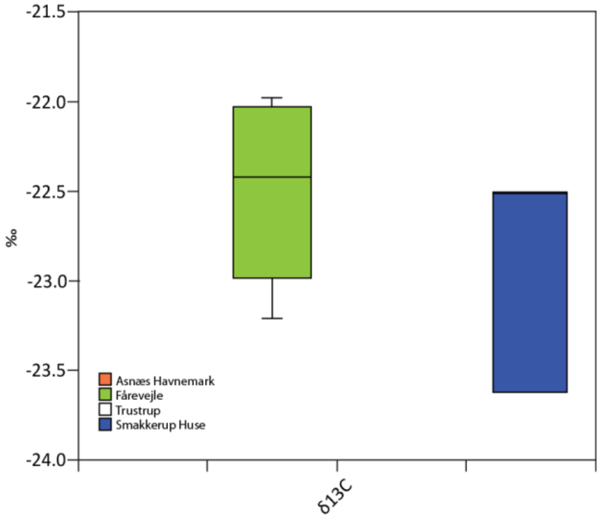


Figure 9.11: Red deer δ^{13}C values in northwest Zealand (N=7)

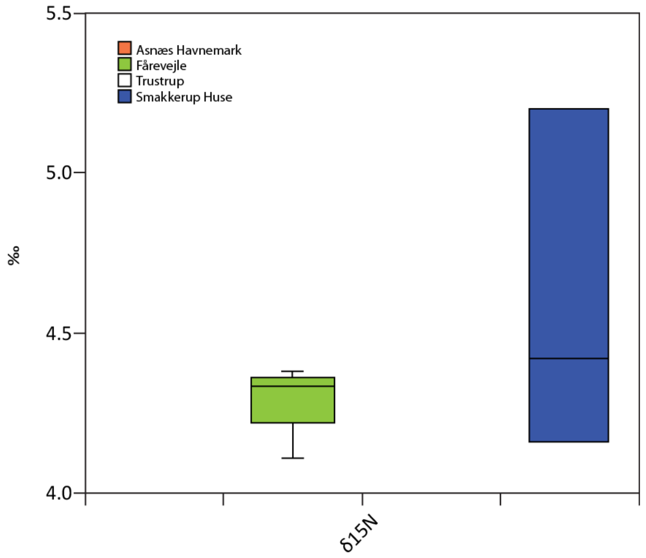


Figure 9.12: Red deer $\delta^{15}N$ values in northwest Zealand (N=7)

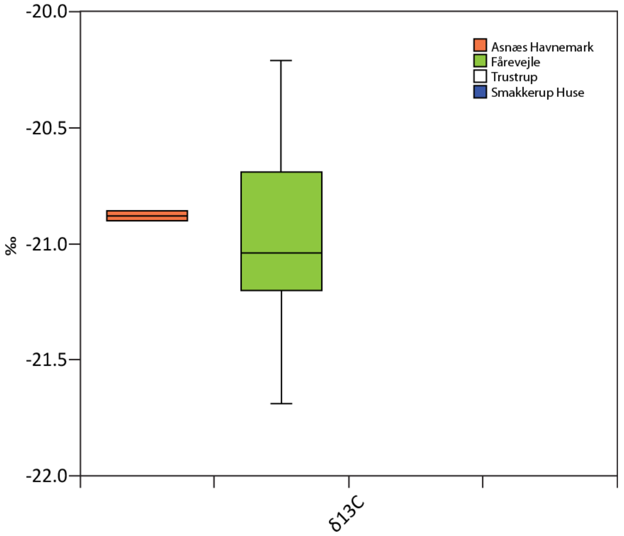


Figure 9.13: Wild boar $\delta^{13}C$ values in northwest Zealand (N=7)

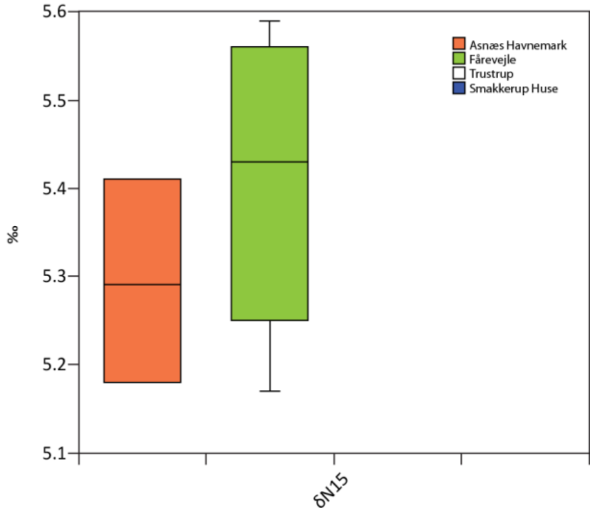
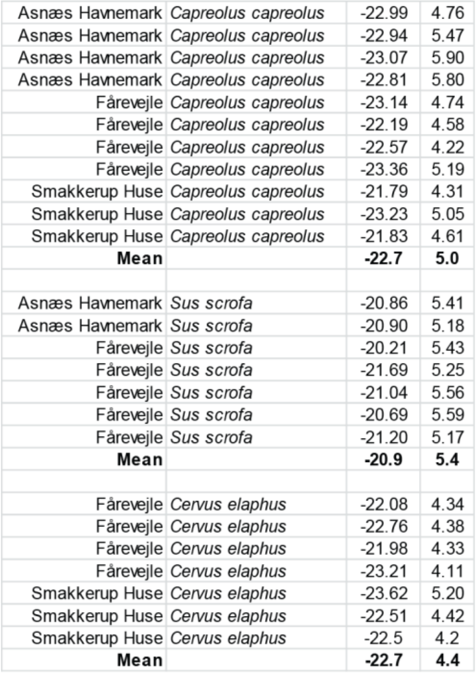


Figure 9.14: Wild boar δ^{15}N values in northwest Zealand (N=7)

When taken together (Table 9.1), these data from a single area establish a baseline for a specific time period as to the full range of expected variability, permitting comparisons with later time periods and locations as has been done earlier in this work (Chapter 8). Due to this significant overlap, baselines in northwest Zealand roe deer average δ^{13}C and δ^{15}N ratios of -22.7‰ and 5.0‰ respectively, wild boar average values are -20.9‰ and 5.4‰, and red deer have average values of -22.7‰ and 4.2‰.



Asnæs Havnemark	*Capreolus capreolus*	-22.99	4.76
Asnæs Havnemark	*Capreolus capreolus*	-22.94	5.47
Asnæs Havnemark	*Capreolus capreolus*	-23.07	5.90
Asnæs Havnemark	*Capreolus capreolus*	-22.81	5.80
Fårevejle	*Capreolus capreolus*	-23.14	4.74
Fårevejle	*Capreolus capreolus*	-22.19	4.58
Fårevejle	*Capreolus capreolus*	-22.57	4.22
Fårevejle	*Capreolus capreolus*	-23.36	5.19
Smakkerup Huse	*Capreolus capreolus*	-21.79	4.31
Smakkerup Huse	*Capreolus capreolus*	-23.23	5.05
Smakkerup Huse	*Capreolus capreolus*	-21.83	4.61
Mean		**-22.7**	**5.0**
Asnæs Havnemark	*Sus scrofa*	-20.86	5.41
Asnæs Havnemark	*Sus scrofa*	-20.90	5.18
Fårevejle	*Sus scrofa*	-20.21	5.43
Fårevejle	*Sus scrofa*	-21.69	5.25
Fårevejle	*Sus scrofa*	-21.04	5.56
Fårevejle	*Sus scrofa*	-20.69	5.59
Fårevejle	*Sus scrofa*	-21.20	5.17
Mean		**-20.9**	**5.4**
Fårevejle	*Cervus elaphus*	-22.08	4.34
Fårevejle	*Cervus elaphus*	-22.76	4.38
Fårevejle	*Cervus elaphus*	-21.98	4.33
Fårevejle	*Cervus elaphus*	-23.21	4.11
Smakkerup Huse	*Cervus elaphus*	-23.62	5.20
Smakkerup Huse	*Cervus elaphus*	-22.51	4.42
Smakkerup Huse	*Cervus elaphus*	-22.5	4.2
Mean		**-22.7**	**4.4**

Table 9.1: Big three isotopic variability (δ^{13}C and δ^{15}N ratios)

As a final note, the average $\delta^{13}C$ values of both red deer and roe deer are extremely similar, indicating that these animals were living in very similar, if not the same environments. This is of interest as sometimes there can be rather strong divergence between preferred habitats of these flexible species (Geist 1998). Average $\delta^{15}N$ values are also quite close to each other, although not identical. This indicates that the two deer species were living in the same environments but were eating dissimilar foods. The result is that in order to obtain these species, it was not a question of finding each in its preferred habitat, but one of simply finding appropriate places to hunt them. This can be taken as evidence that hunting of the big three was not a species-specific activity, but instead all three were taken when encountered.

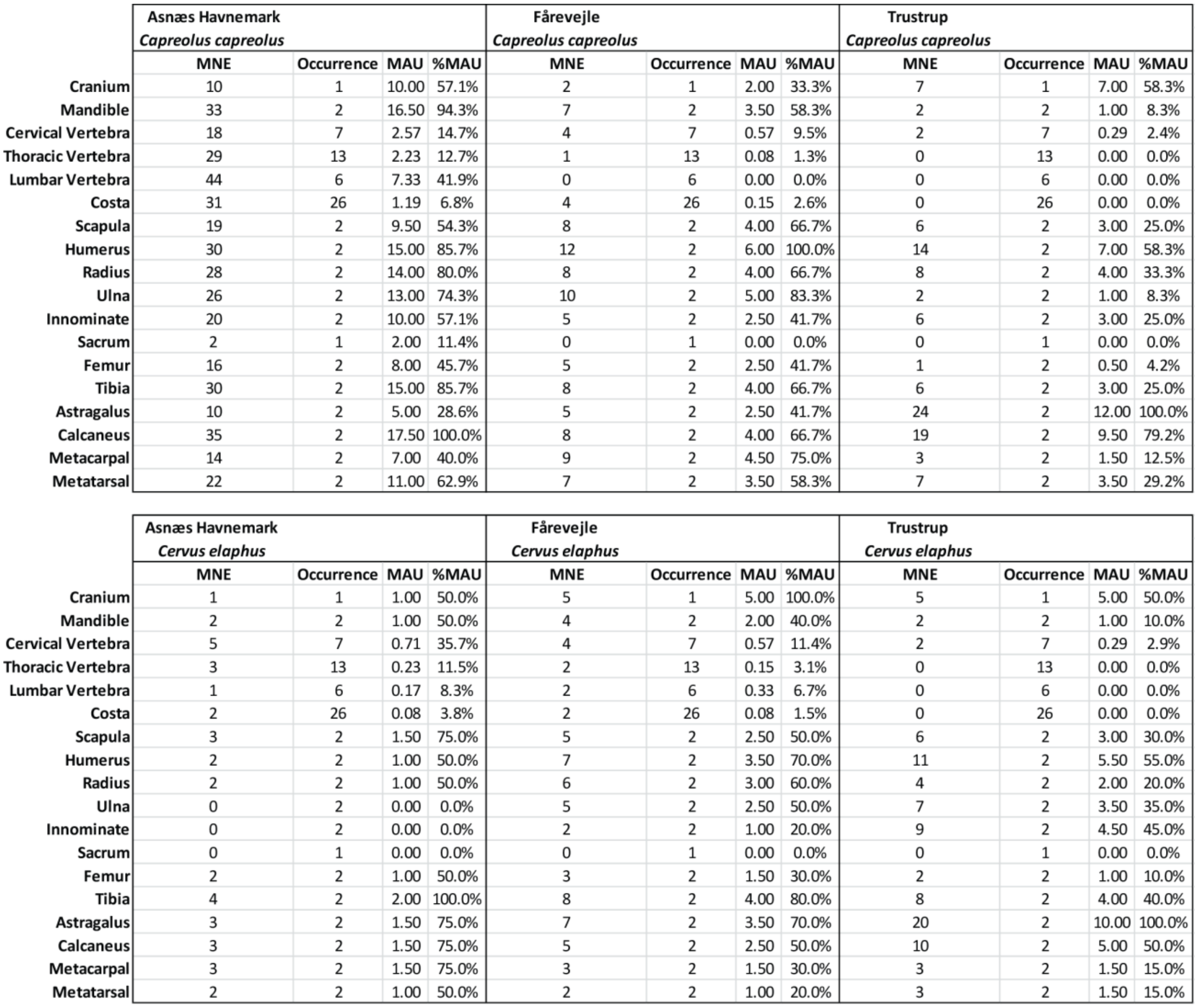
MAU/Butchery/Body Part

Under the general model of resource procurement as proposed by Rowley-Conwy (1983, 1999), based on Binford (1980) and elaborated by Price and Gebauer (2005), EBK collectors ventured out from base camps to smaller, short-term collecting sites, and then brought these resources back to the more generalized base camps. The model involves both radial and logistic components (Rowley-Conwy 1999). This perspective emphasizes an exploitative strategy consistent with a collector model of hunter-gatherer resource exploitation (Binford 1980; Rowley-Conwy 1983; Price and Gebauer 2005). However, this general strategy may have varied within southern Scandinavia during the last centuries of the Atlantic Period. Possible indicators include observed differences in material culture and resource exploitation between regions as well as variation in the available fauna (Aaris-Sørensen 1980, 2009; Petersen 1984; Ritchie 2010).

Of interest for understanding the purpose of a hunter-gatherer archaeological site is whether the bones of the predominant taxa found at the site selectively were transported to that site from elsewhere, butchered at that site and then selectively transported elsewhere, utilized whole, or any permutation of the preceding. Of further interest is whether there are instances of selective butchery and transport reflected in complementary assemblages. Therefore, body-part representation studies have the potential to inform about the role of any given EBK locality. There are only a few studies of skeletal-part representation in EBK contexts, each with differing results and methods (Eriksson and Magnell 2001; Jonsson 1988; Trolle-Lassen 1990; Rowley-Conwy 1994-1995).

The most relevant example that warrants comparison with the data analyzed here is the inland hunting camp at Ringkloster. In that study, Rowley-Conwy (1994-1995), quantified auroch, red deer, and wild boar bone elemental representation using the derived statistic %MAU. Axial elements dominate the auroch and red deer components of the Ringkloster assemblage, with other elements relatively underrepresented (Rowley-Conwy 1994-1995). Wild boar at Ringkloster showed a somewhat different pattern in which only the hindquarters were likely selectively removed from the site. These data were argued to indicate on-site butchery of animals with the transport of limbs elsewhere, presumably to sites on the coast (Rowley-Conwy 1994-1995). Rowley-Conwy then compared the observed patterns to the ethnographically- and archaeologically-studied inland summer caribou hunting camp of Aasivissuit in west Greenland noting the general similarities with Ringkloster (Grønnow, Meldgaard, and Nielsen 1983; Rowley-Conwy 1994-1995). The argument is effective in demonstrating that carcasses were butchered at Ringkloster, and parts were selectively transported. Therefore, studies of this type can be a useful tool for understanding the mechanisms of resource exploitation.

For roe deer and red deer from Asnæs Havnemark, Fårevejle, and Trustrup, MNE values were calculated. These MNE values then were used to calculate %MAU. This method is that used by Rowley-Conwy (1993-1994) and only slightly modified, particularly in terms of which skeletal elements were included in the analysis. Carpals, most tarsals (except the astragalus and calcaneus), and phalanges as well as smaller bones were omitted for both species due to their often very small size, multiplicity in the body, and their potential to be overlooked during excavation. Wild boar are omitted in this comparison due to morphological differences with deer, reported differences in butchery of this species with others in EBK contexts, and the comparative rarity of the species compared to deer at EBK sites on Zealand (Gotfredsen 1998; Magnussen 2007; Møhl 1971; Noe-Nygaard 1995; Rowley-Conwy 1994-1995). However, a similar pattern is seen in their values (Figure 9.1). Most likely, similar processes are ocurring in wild boar as well. Roe deer and red deer data manipulations are shown in Table 9.2.



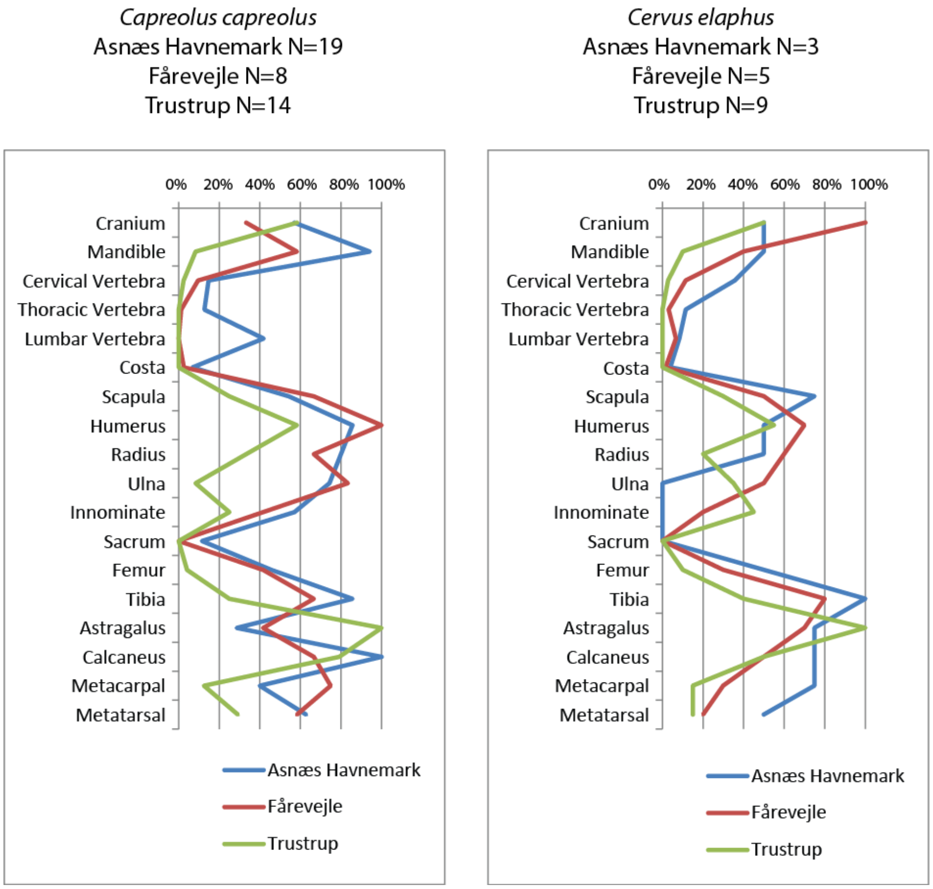
	Asnæs Havnemark				**Fårevejle**				**Trustrup**			
	Capreolus capreolus				***Capreolus capreolus***				***Capreolus capreolus***			
	MNE	**Occurrence**	**MAU**	**%MAU**	**MNE**	**Occurrence**	**MAU**	**%MAU**	**MNE**	**Occurrence**	**MAU**	**%MAU**
Cranium	10	1	10.00	57.1%	2	1	2.00	33.3%	7	1	7.00	58.3%
Mandible	33	2	16.50	94.3%	7	2	3.50	58.3%	2	2	1.00	8.3%
Cervical Vertebra	18	7	2.57	14.7%	4	7	0.57	9.5%	2	7	0.29	2.4%
Thoracic Vertebra	29	13	2.23	12.7%	1	13	0.08	1.3%	0	13	0.00	0.0%
Lumbar Vertebra	44	6	7.33	41.9%	0	6	0.00	0.0%	0	6	0.00	0.0%
Costa	31	26	1.19	6.8%	4	26	0.15	2.6%	0	26	0.00	0.0%
Scapula	19	2	9.50	54.3%	8	2	4.00	66.7%	6	2	3.00	25.0%
Humerus	30	2	15.00	85.7%	12	2	6.00	100.0%	14	2	7.00	58.3%
Radius	28	2	14.00	80.0%	8	2	4.00	66.7%	8	2	4.00	33.3%
Ulna	26	2	13.00	74.3%	10	2	5.00	83.3%	2	2	1.00	8.3%
Innominate	20	2	10.00	57.1%	5	2	2.50	41.7%	6	2	3.00	25.0%
Sacrum	2	1	2.00	11.4%	0	1	0.00	0.0%	0	1	0.00	0.0%
Femur	16	2	8.00	45.7%	5	2	2.50	41.7%	1	2	0.50	4.2%
Tibia	30	2	15.00	85.7%	8	2	4.00	66.7%	6	2	3.00	25.0%
Astragalus	10	2	5.00	28.6%	5	2	2.50	41.7%	24	2	12.00	100.0%
Calcaneus	35	2	17.50	100.0%	8	2	4.00	66.7%	19	2	9.50	79.2%
Metacarpal	14	2	7.00	40.0%	9	2	4.50	75.0%	3	2	1.50	12.5%
Metatarsal	22	2	11.00	62.9%	7	2	3.50	58.3%	7	2	3.50	29.2%

	Asnæs Havnemark				**Fårevejle**				**Trustrup**			
	Cervus elaphus				***Cervus elaphus***				***Cervus elaphus***			
	MNE	**Occurrence**	**MAU**	**%MAU**	**MNE**	**Occurrence**	**MAU**	**%MAU**	**MNE**	**Occurrence**	**MAU**	**%MAU**
Cranium	1	1	1.00	50.0%	5	1	5.00	100.0%	5	1	5.00	50.0%
Mandible	2	2	1.00	50.0%	4	2	2.00	40.0%	2	2	1.00	10.0%
Cervical Vertebra	5	7	0.71	35.7%	4	7	0.57	11.4%	2	7	0.29	2.9%
Thoracic Vertebra	3	13	0.23	11.5%	2	13	0.15	3.1%	0	13	0.00	0.0%
Lumbar Vertebra	1	6	0.17	8.3%	2	6	0.33	6.7%	0	6	0.00	0.0%
Costa	2	26	0.08	3.8%	2	26	0.08	1.5%	0	26	0.00	0.0%
Scapula	3	2	1.50	75.0%	5	2	2.50	50.0%	6	2	3.00	30.0%
Humerus	2	2	1.00	50.0%	7	2	3.50	70.0%	11	2	5.50	55.0%
Radius	2	2	1.00	50.0%	6	2	3.00	60.0%	4	2	2.00	20.0%
Ulna	0	2	0.00	0.0%	5	2	2.50	50.0%	7	2	3.50	35.0%
Innominate	0	2	0.00	0.0%	2	2	1.00	20.0%	9	2	4.50	45.0%
Sacrum	0	1	0.00	0.0%	0	1	0.00	0.0%	0	1	0.00	0.0%
Femur	2	2	1.00	50.0%	3	2	1.50	30.0%	2	2	1.00	10.0%
Tibia	4	2	2.00	100.0%	8	2	4.00	80.0%	8	2	4.00	40.0%
Astragalus	3	2	1.50	75.0%	7	2	3.50	70.0%	20	2	10.00	100.0%
Calcaneus	3	2	1.50	75.0%	5	2	2.50	50.0%	10	2	5.00	50.0%
Metacarpal	3	2	1.50	75.0%	3	2	1.50	30.0%	3	2	1.50	15.0%
Metatarsal	2	2	1.00	50.0%	2	2	1.00	20.0%	3	2	1.50	15.0%

Table 9.2: MNE values and calculation of %MAU

Percent MAU values for a number of elements in the skeleton are shown graphically in Figure 9.15. Roe deer are the most abundant species at each site under consideration in terms of numbers of actual animals, represented by 19 individuals at Asnæs Havnemark, eight individuals at Fårevejle, and 14 individuals at Trustrup. At all sites, animals are best represented by elements of the cranium, forelimb, hindlimb, with the axial skeleton represented to a much lesser degree.

Red deer are represented by fewer actual animals at each site. In this case, the sample at Asnæs Havnemark is three individuals, five at Fårevejle and nine at Trustrup. Despite the small sample sizes, the %MAU pattern is nearly identical to roe deer, with animals best represented by elements of the head, forelimb and hindlimb with the axial skeleton largely absent.


Capreolus capreolus
Asnæs Havnemark N=19
Fårevejle N=8
Trustrup N=14

Cervus elaphus
Asnæs Havnemark N=3
Fårevejle N=5
Trustrup N=9

Figure 9.15: Percent MAU for roe deer and red deer

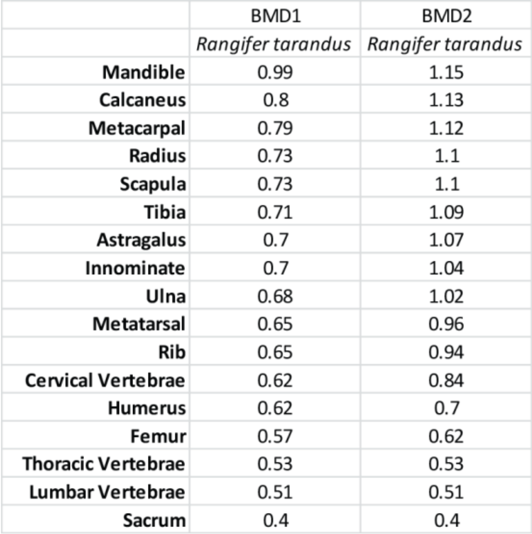
The observed pattern of skeletal-part representation of roe deer is explainable by two possible options. The first is that these three sites represent the counterpoint to the observed pattern at Ringkloster and Aasivissuit (Grønnow et al. 1983; Rowley-Conwy 1994-1995), indicating that all three were localities to which roe deer heads, forelimbs, and hindlimbs were brought. The skeletal pattern observed does appear to be an exact fit for what is missing from the larger-game specimens at hunting sites like Ringkloster and Aaivissuit. Therefore, these three sites could be locations to which the missing elements such as those absent from the two comparative sites could have been transported (Grønnow et al. 1983;

Rowley-Conwy 1994-1995). Following, these three EBK sites in Zealand most certainly do not represent locations from which roe deer are exported elsewhere.

Another option is that the observed pattern is the result of density-mediated skeletal attrition (Lyman 1993). Less dense skeletal elements, particularly elements of the axial skeleton such as the neck and spine, are expected to be more fragile than more-dense elements. Due to their relative fragility these elements are expected to be more affected by taphonomic processes. Therefore, more highly fragmented assemblages can be expected to have fewer fragile bones compared to more robust elements. In highly fragmented assemblages, even when whole carcasses were originally deposited, due to relative skeletal bone densities, there should by far be more head, forelimb, and hindlimb elements than parts of the axial skeleton (Lyman 1993).

From these options, the more likely scenario at Asnæs Havnemark, Fårevejle, and Trustrup is the second, given the presence of some axial elements, significant correlation between published bone density values and obtained %MAU values, the types of sites these locations represent, available seasonality data, and considerations of transport. Percentage MAU values actually show some axial elemental representation in the lesser-fragmented assemblages. That is, the least-fragmented site, Asnæs Havnemark, contains more axial elements (including ca. 42% MAU lumbar vertebrae) than its more-fragmented counterparts. As fragmentation increases in the Fårevejle and Trustrup assemblages, these values decline sharply. This strongly suggests that fragmentation is responsible for lower %MAU values in these less-dense elements.

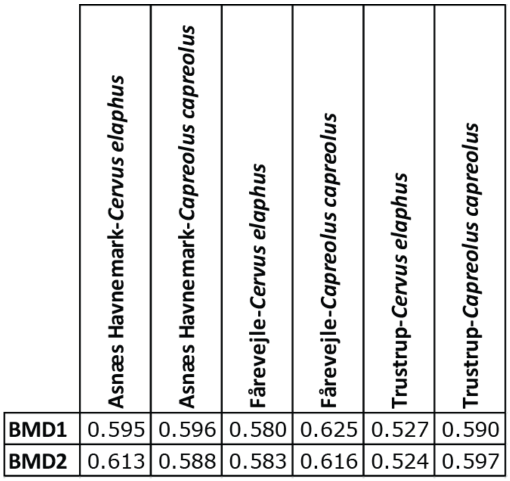
As a test of the relationship between bone density and the observed body-part representation, calculated %MAU values were correlated with published bone density values for reindeer (*Rangifer trandus*). Due to the extensive similarities in bone density patterns between different bovids, equids and cervids (Lam et al. 1999), it is appropriate to compare cervid density values with each other.



	BMD1	BMD2
	Rangifer tarandus	*Rangifer tarandus*
Mandible	0.99	1.15
Calcaneus	0.8	1.13
Metacarpal	0.79	1.12
Radius	0.73	1.1
Scapula	0.73	1.1
Tibia	0.71	1.09
Astragalus	0.7	1.07
Innominate	0.7	1.04
Ulna	0.68	1.02
Metatarsal	0.65	0.96
Rib	0.65	0.94
Cervical Vertebrae	0.62	0.84
Humerus	0.62	0.7
Femur	0.57	0.62
Thoracic Vertebrae	0.53	0.53
Lumbar Vertebrae	0.51	0.51
Sacrum	0.4	0.4

Table 9.3: Data used for Spearman dorrelation from Lam et al. 1999 (if BMD2 not calculated, highest BMD1 value substituted)

Drawing the largest average density values (BMD_1 and BMD_2) for each element included in this study from Lam et al. (1999)(Table 9.3), and using Spearman’s Rank Correlation Test, the null hypothesis that there is no correlation between bone density and observed body-part representation is rejected (P=<0.05, α=0.05, Significance=>.485) for all observations (Table 9.4). All %MAU values show significant correlation with bone density. The two are related.



	Asnæs Havnemark-*Cervus elaphus*	**Asnæs Havnemark-*Capreolus capreolus***	**Fårevejle-*Cervus elaphus***	**Fårevejle-*Capreolus capreolus***	**Trustrup-*Cervus elaphus***	**Trustrup-*Capreolus capreolus***
BMD1	0.595	0.596	0.580	0.625	0.527	0.590
BMD2	0.613	0.588	0.583	0.616	0.524	0.597

Table 9.4: Corrected R_s values for bone mass density (values from Lam et al.1999) versus %MAU by element

Further, it is highly unlikely that each of these three sites represents a base camp or some permutation of a base camp. While Asnæs Havnemark may exhibit occupation over much of the year (Ritchie et al., in review), Fårevejle shows marked seasonality of occupation (Chapter 5). The inland site at Trustrup probably was not a base camp given its location, as most base camps were at the coast during the EBK (Price and Gebauer 2005). Finally, it is doubtful as to whether or not it is actually necessary to butcher a roe deer for transport. Roe deer usually weigh around 17-23 kg (approx. 37-51 lb) (Macdonald 1984) a weight that can be carried for some distance, particularly by two individuals. It is more likely that all parts of the roe deer were initially deposited.

Among the red deer, as well as in comparison to the roe deer, a nearly identical pattern of skeletal element abundances (Figure 9.15) is evident at all three sites. Following the arguments for roe deer, the most likely scenario is that all parts of the animal were present upon deposition due to the similarities in skeletal representation between the two species. However, there are some key differences. Foremost, red deer are significantly larger animals, conservatively averaging at least four times the weight of a roe deer (using values from Geist 1998). This is significantly more weight than a single individual, or even several individuals can transport unaided over a long distance. Therefore, it is probable that the animals were butchered in some way before transport to these three sites. Of course, depending on the time of year, a number of methods including sledges or boats could have been utilized to move such a large carcass whole. Given the similarities with the roe deer %MAU values and given significant correlation of red deer %MAU vales with published density data (Table 9.4), it is again highly likely that a pattern of density-mediated skeletal attrition is responsible. Red deer remains at these three sites resulted from the deposition of entire carcasses.

These data indicate that all parts of deer were deposited at EBK sites in northwest Zealand. The same pattern is observed for both the smaller roe deer and the much larger red deer. Therefore, the most parsimonious explanation for the observed pattern is that these two species were probably not part of a logistic pattern of resource exploitation in northwest Zealand. Lack of evidence for differential transport of body parts shows that these animals represent either a local resource obtained *ad libitum* or were simply abundantly available locally in most areas of Zealand and did not require an elaborate exploitation strategy. The observed pattern reflects bone density-mediated skeletal attrition and not differential transport of specific body-parts. Therefore, movement of hunted deer from site to site is not indicated. Without detailed considerations of patterns of assemblage fragmentation such an assessment is not possible. Therefore, it is advisable to include quantification of fragmentation in zooarchaeological studies in the region. In terms of skeletal-part abundance, the picture in northwest Zealand is one of consistency, where deer transported to all sites analyzed here were deposited whole.

It may be the case that this is the pattern on the whole island. The only other available study reporting this type of data reinforces this possibility. The inland site of Spangkonge in the inland Åmose basin is dated almost precisely to the transition to agriculture on Zealand, at 3960 B.C. and yielded an assemblage quite entirely dominated by red deer (Gotfredsen 2003). Differential body part representation is reported for the red deer materials recovered, shows no major differences between specific body-parts, and indicates no density-mediated attrition (Gotfredsen 2003). The pattern is similar to that observed in northwest Zealand, where there is no selective transport of body-parts.

Fishes

While not a focus of this dissertation, a discussion of fish from northwest Zealand is required, given the preponderance of Pisces in the diets of EBK hunter-gatherers as shown by isotopic and proxy studies of human and dog diets (Fischer et al. 2007; Tauber 1981). In general, isotopic data obtained in this dissertation illustrates a diet almost entirely based on foods from the sea (Chapter 8). This places an enormous caveat on all comparative studies of fauna including this one given the fact that with the exception of seals, all species analyzed here were probably only a minor component of the actual food ingested by EBK individuals. For this reason, perhaps they are best referred to as fisher-hunter-gatherers.

From the four sites in northwest Zealand (Asnæs Havnemark, Fårevejle, Smakkerup Huse, and Trustrup) only Trustrup did not yield large amounts of fishbone. This is probably due to its inland location. Asnæs Havnemark yielded a diverse group of 22 species from 17 families of fish, Fårevejle yielded 14 species from 12 families of fish, Smakkerup Huse yielded 15 species of fish from 10 families, and Trustrup yielded three species from three families of fish (Ritchie 2010; Trustrup specimens identified by K. Ritchie). Sample sizes are also wildly disparate, with 47760 fishbones identified at Asnæs Havnemark, 2738 identified at Fårevejle, 9332 identified at Smakkerup Huse, and only eight specimens attributed to species or family at Trustrup (Ritchie 2010; Price and Gebauer 2005; K. Ritchie personal communication). In reality, the Trustrup fish can only be considered in an anecdotal fashion, although it is interesting that the collection included freshwater catfish specimens.

The other three sites demonstrated a predominance of members of the cod family (Gadidae), never below 50% of the identified specimens, followed to a lesser degree by flatfish (Pleuronectidae), and then to a low level by other types of fish (Ritchie 2010). The general picture is one of dominance of members of the cod family in the EBK fisheries of the region, supplemented by the taking of flatfish. Of note are the similarities with the mammalian fauna in the sense that a lot of species are present, but only few dominate to a much greater degree than the other taxa. If anything, consistency is seen in patterns of exploitation concerning degree to which species are exploited and the breadth of taxa that are capable of being procured.

Zealand

In all, assemblages useable for comparisons on Zealand represent fairly distributed coverage over mostly the northern half of the island. This may be due to the axis of isostatic rebound and sea level rise, which has resulted in the potential submersion of many sites in the southern reaches (Mertz 1924; Christensen 1995; Christensen et al. 1997; Chapter 2). Sites appropriate for comparison island-wide are limited, and consist of the assemblages from Præstelyngen, Spangkonge, Smakkerup Huse, Åkonge, Ølby Lyng, Lollikhuse, and Sølager (Noe-Nygaard 1995; Gotfredsen 2003, 2004a; Møhl 1971; Magnussen 2007; Price and Gebauer 2005; Skaarup 1973). These assemblages were selected on several criteria, including dating predominantly to the EBK and assemblage size greater than 1000 total NISP which results in a higher likelihood of the sample being representative (see Amorosi et al. 1996). This number is largely artificial, but to a certain extent can mitigate variables that were not quantified in past studies such as differences in screening, analyst biases, and degree of fragmentation. Unfortunately, the sample would shrink to zero if all differences in excavation technique, screening, and methodology were controlled. Therefore, these factors must be acknowledged but ignored. This number also was chosen as it is the largest sample which retains a reasonable number of sites for comparison, while addressing the aforementioned complications.

The large assemblage from Nivagård was excluded due to its unclear placement between both the Kongemose and EBK. Bodal K, Muldbjerg and Lollikhuse are discussed separately due to varying degrees of TRB occupation in addition to EBK occupation (Enghoff 2011; Gotfredsen 2004a; Magnussen 2007; Noe-Nygaard 1995). In fact, Muldbjerg and Bodal K may be best thought of as Neolithic. Further, the mammal assemblage from Sølager is actually smaller than 1000 bones, but given the large numbers of bird remains recovered and quantified differently, the assemblage is actually much larger than this criterion. Including the sites reported above in this chapter, there are nine assemblages which can be used to depict variability in EBK resource use on Zealand.

In all, numbers of mammal taxa recovered from sites on Zealand that date exclusively to the EBK based on the criteria above range from seven to 14 species (Table 9.5, in red). In general, inland sites have fewer species than coastal sites. This unsurprising fact is due primarily to the simple fact that fewer species, particularly aquatic species, are available inland than at the coast.

Site	Number of Mammal Species	Number of Mammal Species (normalized)	Number of Bird Species
Agernæs	16	12	6
Aggersund	6	6	1
Asnæs Havnemark	14	14	13
Bökebjerg	13	9	?
Bredasten	13	10	?
Dyrholmen	20	15	13
Ertebølle	13	10	8
Fårevejle	9	9	6
Flynderhage	21	14	8
Hjerk Nor	12	8	2
Lystrup Enge	21	13	14
Norslund	17	13	7
Præstelyng	9	9	17
Ringkloster	18	11	?
Ronæs Skov	18	15	4
Skateholm I	20	14	28
Skateholm II	19	14	15
Smakkerup Huse	13	13	5
Sølager	12	12	2
Spangkonge	7	7	7
Trustrup	11	11	1
Tybrind Vig	12	9	?
Vængesø III	18	15	23
Visborg	13	11	4
Åkonge	8	8	11
Ølby Lyng	13	13	18
Østenkær	17	15	16
Mean	14.2	11.5	10.0
Zealand Mean	10.7	10.7	8.89

Table 9.5: Number of species found at EBK sites (middle column excludes species not present on Zealand for normalization, Zealand sites in red)

At the same sites, bird remains range from what must be a minimum of one species at Trustrup up to a maximum of 18 species recovered at Ølby Lyng (Møhl 1971). Sølager, the one site at which was recovered what may be a preponderance of bird remains, yielded many avian bones which were unfortunately poorly reported as either waterfowl or swans. This is of little use, but it can be safely assumed that among the large avian faunal sample, more than two species probably were present (Skaarup 1973). Further, in context with the other relative abundance data, this fact probably explains the strange appearance of the Sølager assemblage as birds and, indeed, other types of resources, are not included in Figure 9.16. Reinforcing this statement is the great likelihood that marine mollusks were also a likely major contributor to the food economy at Sølager, a shell midden.

If the sites that have at least some early Neolithic occupation are added to the sample, the range becomes seven to 14 species of mammal, and one to 31 species of birds at Muldbjerg I (Noe-Nygaard 1995). Unfortunately, numbers of taxa of avian specimens are of limited use, given the fragility of the sample, differences in sample size, reporting, and quality of analyses. Due to the extreme variability of the sample, it is very likely that recovery techniques, fragmentation, and other factors are influencing. In most cases these influences were not quantified. Therefore, aside their use in seasonality studies, for general mention, and in special circumstances such as the assemblage at Sølager, birds are not particularly informative in this context. Omitting birds from the sites with Neolithic occupations neither seems to alter the overall range of numbers of species, nor disagrees with the overall trends of more species at the coast than in the interior.

Unfortunately, MNI values are rarely reported. Data for all nine sites that are directly comparable is reduced to relative abundance values expressed in NISP of mammals and numbers of species of mammals, birds, and fishes. MNI values can be discussed for only six sites. Adding Neolithic occupation sites, the sample expands to 12 localities that have comparable NISP data and eight that have comparable MNI values. Quantitative relative abundance data is selected based on the criteria discussed above for the sites located in Northwest Zealand and are displayed in Figures 9.16 and 9.17, and Tables 9.6 and 9.7. Cattle, horses, dolphins, and elk (cattle at several sites and a single specimen of each of the others at Lollikhuse, Ølby Lyng and Sølager respectively) are excluded from the data, (Magnussen 2007;

Møhl 1971; Skaarup 1973)) as are unsure identifications. However, values quantifying the numbers of mammal species at the sites do include other marine mammals excluded from quantification by grouping (e.g. seal species conflated to "seal").

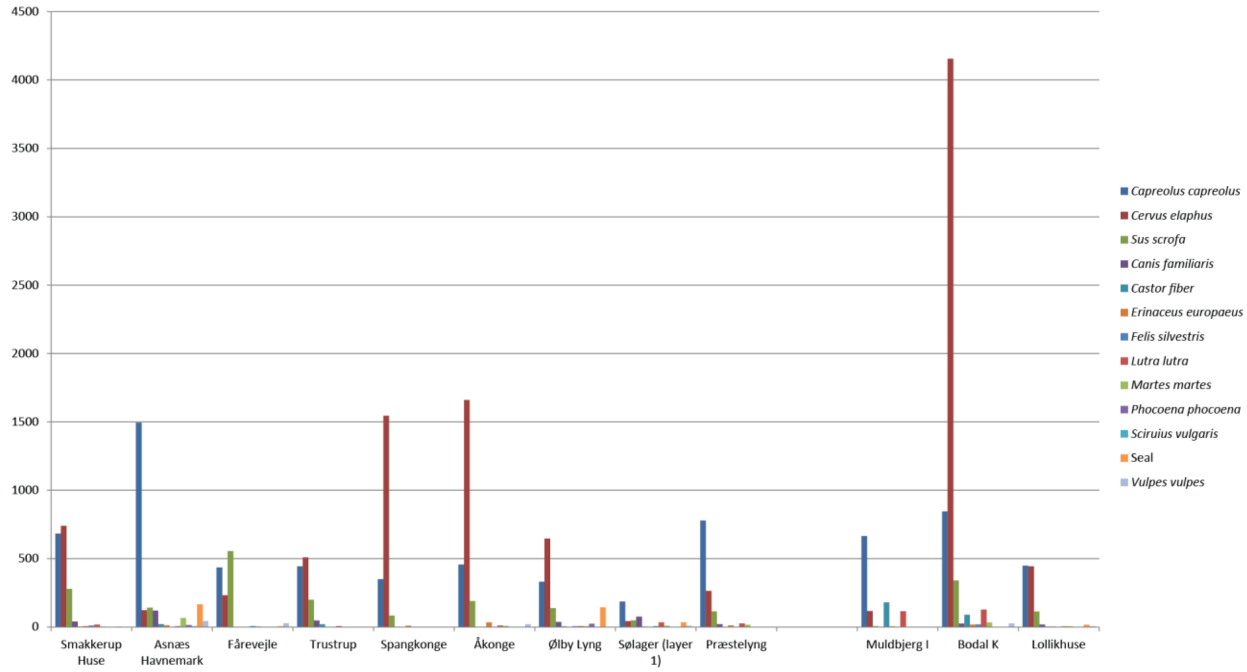


Figure 9.16: NISP values for sites on Zealand (sites on the right have at least some Neolithic dates)

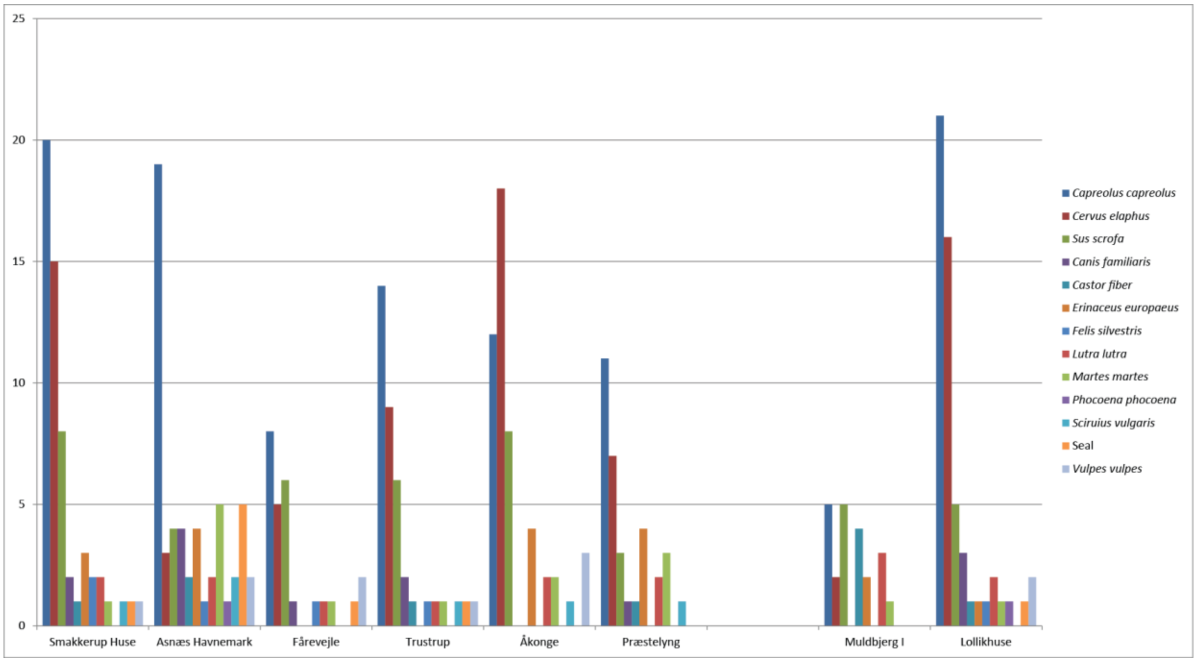


Figure 9.17: MNI values for sites on Zealand (sites on the right have at least some Neolithic dates)

	Capreolus capreolus	*Cervus elaphus*	*Sus scrofa*	*Canis familiaris*	*Castor fiber*	*Erinaceus europaeus*	*Felis silvestris*	*Lutra lutra*	*Martes martes*	*Phocoena phocoena*	*Sciruius vulgaris*	Seal	*Vulpes vulpes*
Asnæs Havnemark	68%	6%	6%	5%	1%	1%	0%	0%	4%	1%	0%	9%	2%
Fårevejle	34%	18%	44%	0%	0%	0%	0%	0%	0%	0%	0%	0%	1%
Præstelyng	63%	21%	9%	2%	0%	1%	0%	1%	1%	0%	0%	0%	0%
Smakkerup Huse	38%	41%	16%	2%	0%	0%	1%	1%	0%	0%	0%	0%	0%
Sølager (layer 1)	42%	9%	11%	17%	1%	0%	0%	2%	1%	0%	0%	2%	1%
Spangkonge	18%	78%	4%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Trustrup	36%	41%	16%	4%	2%	0%	0%	0%	0%	0%	0%	0%	0%
Åkonge	19%	70%	8%	0%	0%	1%	0%	1%	0%	0%	0%	0%	1%
Ølby Lyng	25%	48%	10%	3%	0%	0%	0%	0%	0%	1%	0%	8%	0%
MEAN	**38%**	**37%**	**14%**	**4%**	**0%**	**0%**	**0%**	**1%**	**1%**	**0%**	**0%**	**2%**	**1%**
Bodal K	15%	73%	6%	0%	2%	0%	1%	7%	2%	0%	0%	0%	1%
Lollikhuse	42%	42%	11%	2%	0%	0%	0%	0%	0%	0%	0%	1%	0%
Muldbjerg I	61%	11%	0%	0%	16%	0%	0%	6%	0%	0%	0%	0%	0%
MEAN (including early Neolithic)	**38%**	**38%**	**12%**	**3%**	**2%**	**0%**	**0%**	**2%**	**1%**	**0%**	**0%**	**2%**	**1%**

Table 9.6: NISP values for Zealand expressed as percentages (superlatives in red)

	Capreolus capreolus	*Cervus elaphus*	*Sus scrofa*	*Canis familiaris*	*Castor fiber*	*Erinaceus europaeus*	*Felis silvestris*	*Lutra lutra*	*Martes martes*	*Phocoena phocoena*	*Sciruius vulgaris*	Seal	*Vulpes vulpes*
Smakkerup Huse	34%	26%	14%	3%	2%	5%	3%	3%	2%	0%	2%	2%	2%
Asnæs Havnemark	35%	6%	7%	7%	4%	7%	2%	4%	9%	2%	4%	9%	4%
Fårevejle	32%	20%	24%	4%	0%	0%	4%	4%	4%	0%	0%	4%	8%
Trustrup	37%	24%	16%	5%	3%	0%	3%	3%	3%	0%	3%	3%	3%
Åkonge	24%	37%	16%	0%	0%	8%	0%	4%	4%	0%	2%	0%	6%
Præstelyng	31%	20%	9%	3%	3%	11%	0%	6%	9%	0%	3%	0%	0%
MEAN	**32%**	**22%**	**14%**	**4%**	**2%**	**5%**	**2%**	**4%**	**5%**	**0%**	**2%**	**3%**	**4%**
Muldbjerg I	20%	8%	20%	0%	16%	8%	0%	12%	4%	0%	0%	0%	0%
Lollikhuse	38%	29%	9%	5%	2%	2%	2%	4%	2%	2%	0%	2%	4%
MEAN (including early Neolithic)	**32%**	**21%**	**14%**	**4%**	**3%**	**5%**	**2%**	**5%**	**5%**	**0%**	**2%**	**2%**	**3%**

Table 9.7: MNI values for Zealand expressed as percentages (superlatives in red)

The overall picture in terms of relative abundance is best expressed in percentages, utilizing published NISP and MNI values (Tables 9.6 and 9.7) and then normalizing the values based on the overall sample. Using both statistics, remarkable uniformity in terrestrial mammal utilization is observed on the island of Zealand. This is in stark contrast to what is seen on a broader, culture-wide scale (Ritchie et al., in review). With the exception of the species that simply are not present (Aaris-Sørensen 1980; 2009), all terrestrial and marine mammals are in evidence in these assemblages. Given their presence the EBK hunters on the island certainly were capable of acquiring these resources (Ritchie et al., under review).

Regarding the mammal and bird remains, all sites on Zealand are hunting camps for the procurement of the big three, or at least one of those species is always dominant in the assemblage. Further, those sites which exhibit somewhat aberrant number of other species, which in this case is defined as assemblages that demonstrate greater than 10% representation in both MNI and NISP are extremely limited. The only three assemblages that fit these criteria are Muldbjerg I, where beaver make up over 10% of both MNI and NISP numbers, Sølager, where dogs make up more than 10% of NISP, and Præstelyng where hedgehogs make up somewhat more than 10% of the NISP values. Regardless, none of these sites can remotely be described as focused on any of these resources. They are dominated still by the big three. While Muldbjerg I has rather high numbers of beaver, it is fully early Neolithic in age; even then the taxon makes up less than a quarter of the assemblage. At Sølager, dogs are more common than normal. In terms of pure numbers birds are most common. Sølager may very well be the only location that cannot be referred to as a hunting camp for red deer, roe deer, and wild boar given the dominance of birds, however poorly quantified. But, birding surely could not have been the only focus of procurement, since the site is a shell midden, and, clearly, collecting of mollusk shell was a primary activity. Given the data and dominance of the three species of larger game animals, and ignoring fish remains at the site, one may be tempted to call the residents of the island of Zealand specialized large-game hunters.

The previous statement is flagrantly problematic given the large numbers of fish remains recovered from nearly every coastal site under consideration in this section (Ritchie 2010; Price and Gebauer 2005).

However, the inland sites, especially those in the Store Åmose may very well be called specialized large-game hunting camps, in particular Åkonge and Spangkonge. These sites had very small fish assemblages, and therefore may be considered to have been localities where few economic activities other than the hunting of red deer occurred. Problematic though are the overall similarities between *all* sites, coastal and inland. The relative abundances at all sites still show very little deviation, especially among the mammals from the general pattern of being dominated by the big three. Further, fewer species of mammals are seen at inland sites then at coastal sites. But, considering the similarities in abundances and similar ubiquitous use of species, the inland sites that appear more specialized in terms of having fewer species of mammal and little fishing are separated from those at the coast by one simple and obvious factor: availability. Where species are present, they are procured, and where they are not, they are not. Therefore, there are no specialized EBK sites on Zealand that are the result of deliberate and differentiated procurement of very particular resources at a given period of the year in the fashion seen elsewhere in the EBK area. Some sites are seasonal, but point even then to rather generalized procurement strategies, where many taxa and classes and birds are procured. The closest examples of what may be logistic sites are Asnæs Havnemark, Sølager, and Åkonge or Spangkonge, and these can be explained either by local availability or lack of resources (Åmose sites), or by dominance of a single class of species but with still prominent and significant use of other resources (Asnæs Havnemark and Sølager).

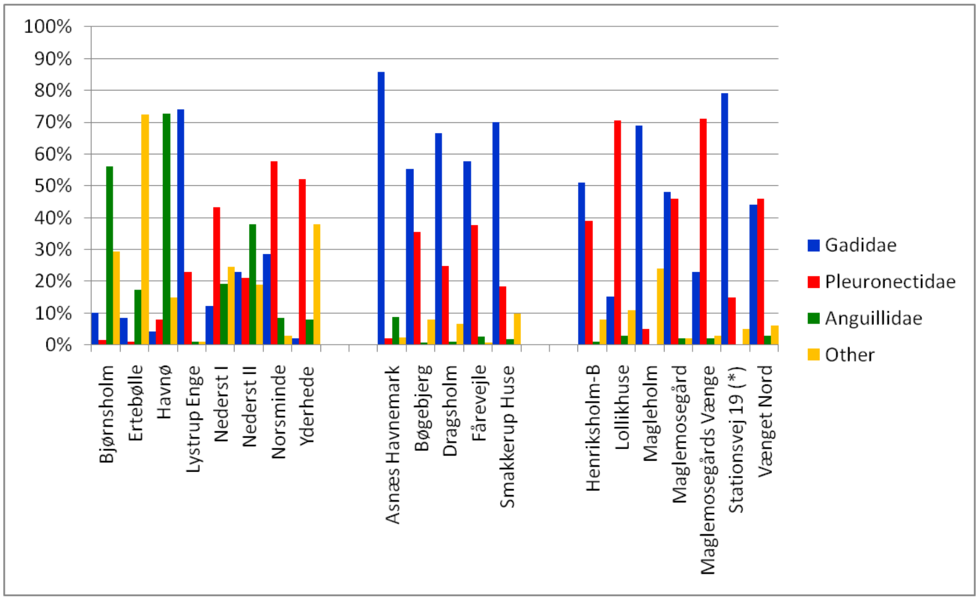


Figure 9.18: Relative abundance of fishes at EBK sites (arranged L-R Western EBK, NW Zealand, and NE Zealand) (from Ritchie 2010:154 used with permission).

Fish data from the coastal sites and within individual regions of the island of Zealand appear similar to the mammals in terms of the dominance of few species with the usage of little else (Figure 9.18; Ritchie 2010). Without a doubt the coastal fisheries of Zealand were focused on the cod family (Gadidae) and flatfish (Pleuronectidae). All Zealand assemblages contain a predominance of species from those two families (Ritchie 2010). As discussed above, in northwest Zealand dominance of codfish is the rule, followed by flatfish. In northeast Zealand, some sites are dominated by codfish and some by flatfish. Everywhere however, there is little else appearing in the assemblages, with the exception of Magleholm, where other species do make up more than 20% of the recovered fish remains (Ritchie 2010). Regardless, fishing on the island can be described as mostly focused on two types of fish. It is also clear, however, that the EBK fishers were fully capable of obtaining a large variety of fish if needed.

Whole EBK

Comparative study of variability in EBK faunal assemblages across the culture area is a daunting task due to the vast number of differing approaches to excavation, analysis, and reporting of faunal assemblages at these sites. This is further confounded by differences in sample size and preservation. In the absence of MNI data for the vast majority of sites outside of Zealand, unfortunately, the comparative analyst is required to use only NISP values, which are problematic for numerous reasons. Sample size is a relative measure of assemblage size, but one that it is unclear as to its meaning. Nobody would argue that an assemblage containing five bones that have been attributed to species is representative of the spread of species or any aspect of an ancient human economy. However, few people would argue that an assemblage of one million bones attributable to species is *not* representative of an ancient faunal economy, regardless of the type of site. The problem lies in the middle, when one must decide how large is large enough to be representative. This issue is further confounded by the fact that there are numerous influencing factors when it comes to sample size. In the simplest terms, larger is not always better and vice-versa. An example would be a single tibia from a red deer. In one study, an entire tibia would count as a single value of one (NISP=1), whereas if an individual breaks out the middle of the same tibia, throws it away and then has the proximal and distal ends that do not refit remaining, one would have two fragments, or NISP=2. Therefore, fragmentation is everything. However, means to quantify this degree of fragmentation, save for this study and few others, are not published or recorded. Such means include measuring all bones in an assemblage or taking the ratio of NISP to MNI (Lyman 1994a). Except for the sites studied here for northwest Zealand, these values are not available for the many sites that have been published. Qualitative descriptions of preservation and degree of fragmentation do not adequately address this problem. In terms of comparison, the simple rule bigger is better must be followed in order to make any sort of quantitative comparison between assemblages. How big then becomes the question. Given the corpus of published assemblages and taking overall numbers into consideration, Stone Age assemblages generally number several hundred to thousands of specimens. Some assemblages number several thousand bones identifiable to species (see Appendix IX).

Ultimately, a decision needs to be made balancing the number of assemblages included in a comparative analysis with number of bones determined per assemblage. The numbers of specimens in included assemblages share an inverse relationship with the numbers of assemblages that can be included. Therefore, the line must be drawn somewhere. For the purposes of this culture-wide analysis, the required number of bones to have been identified to species is 500. This allows a reasonably large group of sites to be assessed, while at the same time keeping samples at each site relatively large. Two exceptions with smaller samples are included as well concerning the mammal remains. These are the assemblages from Aggersund and Sølager, which both included very large numbers of birds (Skaarup 1973; Møhl 1978), quantified separately. While primary comparisons here are between mammal species and not birds due to reasons described above, these assemblages with the birds included exceed 500 bone specimens and therefore are included as it is assumed the mammal proportion is representative.

Sample size aside, diverse methods were used for identifications of the bones to be compared. The following criteria were used in an effort to mitigate these problems. 1) All tentative and/or mixed identifications are dropped. 2) Seals are an exception and are grouped due to difficulties differentiating individual species but owing to the ease by which a specimen may be identified as simply a seal. 3) At EBK sites domesticated animals are considered to have been later contaminates. As these are always low numbers, this does not affect interpretations. 4) Wolves are not considered present on Zealand as they are exceedingly rare and I am not convinced they were resident during the EBK. 5) Whales except for harbour porpoises, horses, bears, hares, and other very rare species are dropped due to very low representation culture-wide. 6) Swine and *Bos* sp. are considered to have been wild species if this is possible, as on Jutand aurochs are present (Aaris-Sørensen 1980). Otherwise, they are dropped (as on Zealand, where there are no aurochs) due to low numbers. 7) Sites that included presence or absence values for species were not included, due to their ambiguity concerning relative abundance, with the exception of Ringkloster owing to its importance as re-reported by Richter and Noe-Nygaard (2003). In that case, animals listed as present were included in species counts, but not relative abundance counts. 8) Only sites confidently attributable to the EBK are included.

Under these criteria, a sample of 27 EBK sites where the vast majority of the cultural materials date to the EBK or sites where the EBK materials fit the criteria were selected. These sites include Agernæs, Aggersund, Asnæs Havnemark, Bredasten, Bökebjerg III, Dyrholmen, Ertebølle, Flynderhage, Fårevejle, Hjerk Nor, Lystrup Enge, Norslund, Præstelyng, Ringkloster, Ronæs Skov, Skateholm I, Skateholm II, Smakkerup Huse, Spangkonge, Sølager, Trustrup, Tybrind Vig, Visborg, Vængesø III , Åkonge, Ølby Lyng, and Østenkær (Andersen and Malmros 1966; Enghoff 2011; Eriksson and Magnell 2001; Gotfredsen 1998, 2003; Hatting et al. 1973; Jonsson 1988; Madsen et al. 1900; Magnell unpublished cited in Imperiale 2011; Mathiassen et al. 1942; Møhl 1971, 1978; Noe-Nygaard 1995; Price and Gebauer 2005; Richter and Noe-Nygaard 2003; Skaarup 1973). Further archaeological background for these localities is available in Chapter 2. In the case of old and new excavations at the same site and separate publications, as is the case with Ertebølle and Fårevejle, the old publication is considered superseded by the new publication. Old data are not included. Admittedly,old data can be useable, but discrepancies in methodology make multiple analyses separated by over a hundred years (for example Enghoff 2011 and Madsen et al. 1900 at Ertebølle) incongruent on a basic level. This problem is mitigated by ignorance of the old data. Manipulated selected data are listed in Table 9.8 and Figure 9.19.

	Capreolus capreolus	*Cervus elaphus*	*Sus scrofa*	*Alces alces*	*Bos primigenius*	*Canis familiaris*	*Canis lupus*	*Castor fiber*	*Erinaceus europaeus*	*Felis silvestris*	*Lutra lutra*	*Lynx lynx*	*Martes martes*	*Meles meles*	*Mustela putorius*	*Phocoena phocoena*	*Sciruius vulgaris*	Seal	*Vulpes vulpes*	**Big Three**	**Big Game**
Agernæs	21%	34%	4%	0%	0%	7%	0%	0%	0%	3%	1%	0%	29%	0%	0%	0%	0%	0%	2%	**58%**	**58%**
Aggersund	2%	19%	56%	0%	0%	9%	0%	0%	13%	0%	1%	0%	0%	0%	0%	0%	0%	0%	0%	**77%**	**77%**
Dyrholmen	14%	36%	34%	2%	7%	2%	0%	0%	0%	1%	1%	0%	1%	1%	0%	0%	0%	0%	0%	**84%**	**93%**
Ertebølle	36%	31%	22%	0%	0%	2%	0%	0%	0%	1%	0%	0%	1%	0%	0%	0%	0%	1%	4%	**90%**	**90%**
Flynderhage	9%	18%	31%	1%	16%	6%	0%	0%	0%	0%	0%	0%	10%	1%	0%	0%	0%	7%	1%	**58%**	**74%**
Hjerk Nor	0%	20%	16%	0%	14%	3%	0%	0%	0%	32%	6%	2%	4%	1%	0%	0%	0%	0%	2%	**36%**	**50%**
Lystrup Enge	12%	35%	26%	3%	22%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	**73%**	**98%**
Norslund	12%	23%	29%	1%	25%	2%	0%	0%	0%	1%	0%	0%	1%	1%	0%	0%	0%	4%	1%	**64%**	**89%**
Østenkær	20%	52%	21%	0%	0%	0%	0%	0%	0%	0%	0%	0%	1%	0%	0%	0%	0%	5%	0%	**93%**	**94%**
Ringkloster	3%	33%	38%	0%	6%	1%	0%	0%	0%	0%	2%	0%	15%	0%	0%	0%	0%	0%	1%	**74%**	**80%**
Ronæs Skov	16%	36%	33%	0%	0%	3%	0%	0%	0%	3%	1%	0%	1%	0%	0%	1%	0%	7%	0%	**84%**	**84%**
Tybrind Vig	8%	22%	11%	0%	0%	3%	0%	0%	0%	6%	7%	0%	38%	0%	2%	0%	0%	1%	0%	**42%**	**42%**
Vængesø III	11%	3%	19%	0%	1%	9%	0%	0%	0%	2%	1%	0%	10%	1%	0%	1%	0%	39%	3%	**33%**	**34%**
Visborg	16%	31%	39%	3%	3%	2%	0%	0%	0%	1%	0%	0%	0%	0%	0%	0%	0%	4%	0%	**85%**	**92%**
Jutland and Fyn Mean	**13%**	**28%**	**27%**	**1%**	**7%**	**3%**	**0%**	**0%**	**1%**	**4%**	**2%**	**0%**	**8%**	**0%**	**0%**	**0%**	**0%**	**5%**	**1%**	68%	75%
Asnæs Havnemark	68%	6%	6%	0%	0%	5%	0%	1%	1%	0%	0%	0%	3%	0%	0%	1%	0%	8%	2%	**80%**	**80%**
Fårevejle	34%	18%	44%	0%	0%	0%	0%	0%	0%	1%	0%	0%	0%	0%	0%	0%	0%	0%	2%	**97%**	**97%**
Præstelyng	63%	21%	9%	0%	0%	2%	0%	0%	1%	0%	2%	0%	1%	0%	0%	0%	0%	0%	0%	**94%**	**94%**
Smakkerup Huse	38%	41%	16%	0%	0%	2%	0%	0%	0%	1%	1%	0%	0%	0%	0%	0%	0%	0%	0%	**95%**	**95%**
Sølager (layer 1)	42%	9%	11%	0%	0%	17%	0%	1%	0%	1%	7%	0%	2%	0%	0%	0%	0%	7%	2%	**62%**	**62%**
Spangkonge	18%	78%	4%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	**99%**	**99%**
Trustrup	36%	41%	16%	0%	0%	4%	0%	2%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	**93%**	**93%**
Åkonge	19%	70%	8%	0%	0%	0%	0%	0%	1%	0%	0%	0%	0%	0%	0%	0%	0%	0%	1%	**97%**	**97%**
Ølby Lyng	25%	48%	10%	0%	0%	3%	0%	0%	0%	0%	0%	0%	0%	0%	0%	2%	0%	11%	0%	**83%**	**83%**
Zealand Mean	**38%**	**37%**	**14%**	**0%**	**0%**	**4%**	**0%**	**0%**	**0%**	**0%**	**1%**	**0%**	**1%**	**0%**	**0%**	**0%**	**0%**	**3%**	**1%**	89%	89%
Bökebjerg III	10%	67%	12%	8%	0%	1%	0%	0%	0%	0%	0%	0%	1%	0%	0%	0%	0%	0%	0%	**90%**	**97%**
Bredasten	8%	28%	60%	0%	0%	1%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	2%	0%	**96%**	**96%**
Skateholm I	16%	17%	42%	0%	0%	1%	1%	1%	0%	2%	3%	0%	0%	0%	0%	0%	0%	13%	2%	**75%**	**75%**
Skateholm II	46%	12%	29%	0%	0%	0%	0%	0%	1%	1%	1%	0%	1%	0%	0%	0%	0%	7%	0%	**88%**	**88%**
Sweden Mean	**20%**	**31%**	**36%**	**2%**	**0%**	**1%**	**0%**	**0%**	**0%**	**1%**	**1%**	**0%**	**0%**	**0%**	**0%**	**0%**	**0%**	**5%**	**1%**	87%	89%
Overall Mean	**22%**	**31%**	**24%**	**1%**	**4%**	**3%**	**0%**	**0%**	**1%**	**2%**	**1%**	**0%**	**4%**	**0%**	**0%**	**0%**	**0%**	**4%**	**1%**	78%	82%

Table 9.8: EBK large-sample mammal faunal data (inclusions explained above)

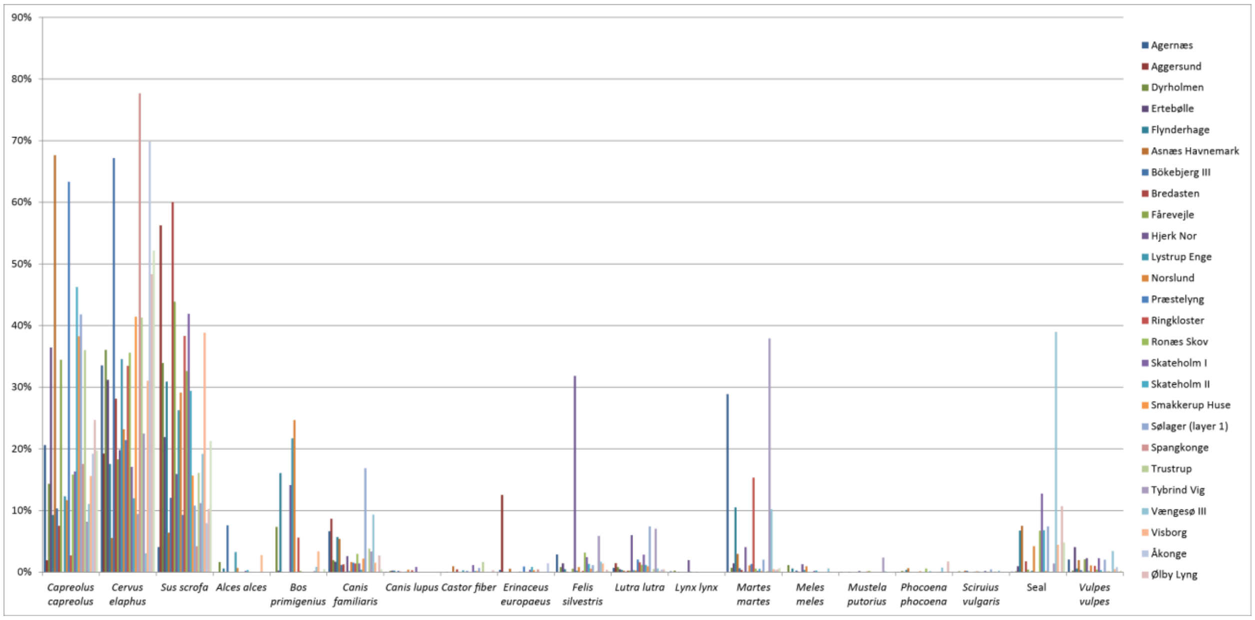


Figure 9.19: EBK large-sample mammal faunal data expressed by species

In Table 9.8, data are presented as percentages of the whole assemblage, with superlatives highlighted in red. Sites are separated geographically, with sites grouped into Jutland and Fyn, Zealand, or Sweden. No appropriate, EBK-only sites were available from Germany and Poland for this analysis due to small sample sizes or mixed contexts in their reporting. Of particular note is the absence of several of the species on Zealand, including elk, aurochs, wolves, lynx, badgers, and polecats, a fact reflected in their absence in these assemblages as well (Aaris-Sørensen 1980; 2009).

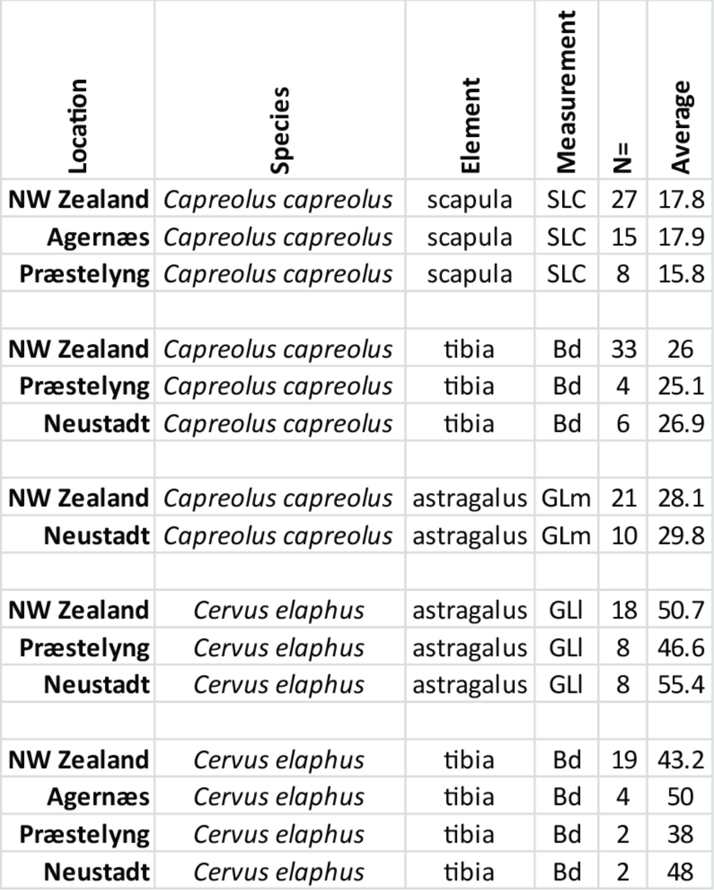
The total numbers of species found in these assemblages is also shown in Table 9.5. In all, the number of species found within this sample averages 14.2 species per site, ranging from six up to 21 species of mammal using the criteria delineated above. In general, more species are found at EBK sites elsewhere than on Zealand (Zealand average 10.7 versus the overall average of 14.2 species). However, when normalized for local extinctions on Zealand (e.g. these species removed), average numbers of mammal species drop to a similar value to that found on Zealand (11.5). In this sense, it appears that narrower breadth of resource use on the island is simply a result of availability. Numbers of bird species vary wildly from one to 28 species. In consideration of overall sample-size then as a basis of selection (e.g. >500 NISP), this wide variability is due most likely to preservation conditions and recovery techniques. There is no consistent pattern of recovery or numbers of species. This again reiterates the limited utility of recovered bird remains in comparative studies of EBK resource use.

The most obvious pattern, when arranged geographically, is that big-game hunting, as an overall percentage of what is being taken, is more prevalent in the eastern EBK than in the western EBK as an overall percentage of what is being taken. One might be tempted to argue that this is due to the absence of several species other than big game on the island of Zealand, but the species that are absent are nowhere near particularly important resources for EBK hunters. This is further reinforced by the fact that the non-big-game species that are being hunted and appear in appreciable numbers at all sites are present ubiquitously across the EBK culture area. When pooled, it is clear that EBK hunters preferred wildcats, otters, foxes and especially pine marten for furs. Red squirrels, polecats, badgers, lynx, and beaver simply were not very important fur animals, so local extinctions probably did not affect their representation in EBK sites on Zealand. Further, elk really cannot be considered to have been a major game prey of EBK hunters. The reasons for this are unclear.

Of further interest in this discussion are the similarities between the pattern observed in mammal exploitation between areas of the EBK and the pattern observed in fish exploitation between the very same areas (Ritchie 2010). Fish exploitation in coastal Zealand is quite homogenous, with flatfish and codfish ubiquitous in the assemblages. The same is not true for fishing elsewhere in the EBK area, particularly on Jutland, where several sites (Figure 9.18) show dominance of species other than codfish and flatfish. In fact, the pattern on Zealand is that there is no pattern. No generalized statement can be made about fish exploitation except that it appears to be location-specific.

It has been argued previously that there is a marked size reduction in the big three game species between the western EBK (Jutland and Fynen) and the island of Zealand during the Atlantic period (Richter and Noe-Nygaard 2003). This is based on similarities between body-size of these taxa between Jutland and Fyn and dissimilarities between those two areas and Zealand (Richter and Noe-Nygaard

2003). These facts were then used to argue that the animal populations in the western EBK were freely connected and that those on Zealand were isolated and therefore smaller implying some sort of depression in the population. When the northwest Zealand data are pooled and compared with broadly contemporary measurements from Agernæs (Richter and Noe-Nygaard 2003) which is located on the northern shores of Fyn, Præstelyng (Noe-Nygaard 1995) located in the Åmose, and Neustadt (Glykou 2011) located in northern Germany, it is clear that this interpretation is an oversimplification of size trends (Table 9.9).



Location	Species	Element	Measurement	N=	Average
NW Zealand	*Capreolus capreolus*	scapula	SLC	27	17.8
Agernæs	*Capreolus capreolus*	scapula	SLC	15	17.9
Præstelyng	*Capreolus capreolus*	scapula	SLC	8	15.8
NW Zealand	*Capreolus capreolus*	tibia	Bd	33	26
Præstelyng	*Capreolus capreolus*	tibia	Bd	4	25.1
Neustadt	*Capreolus capreolus*	tibia	Bd	6	26.9
NW Zealand	*Capreolus capreolus*	astragalus	GLm	21	28.1
Neustadt	*Capreolus capreolus*	astragalus	GLm	10	29.8
NW Zealand	*Cervus elaphus*	astragalus	GLl	18	50.7
Præstelyng	*Cervus elaphus*	astragalus	GLl	8	46.6
Neustadt	*Cervus elaphus*	astragalus	GLl	8	55.4
NW Zealand	*Cervus elaphus*	tibia	Bd	19	43.2
Agernæs	*Cervus elaphus*	tibia	Bd	4	50
Præstelyng	*Cervus elaphus*	tibia	Bd	2	38
Neustadt	*Cervus elaphus*	tibia	Bd	2	48

Table 9.9: Average body-size measurements for northwest Zealand and elsewhere (data from Glykou 2011, Noe-Nygaard 1995, and Richter and Noe-Nygaard 2003).

From these measurements, it is clear that there is an overall trend of *larger* roe deer and red deer body size between northwest Zealand and the inland site at Præstelyng in the Åmose. Animals from the coast are larger than those in the deep interior. Such a difference in size trends may be due to any number of factors including overhunting in the interior and less than optimum environments in that area.

Regardless, it is clear that there may be different populations subjected to different stresses in coastal and interior Zealand during the EBK. Therefore, Zealand cannot be said to have contained ubiquitous homogenous populations of prey animals of similar quality and size.

Second, the roe deer from northwest Zealand are more similar in size to their counterparts from Neustadt in northern Germany and Agernæs in northern Fyn than expected (Glykou 2011; Richter and Noe-Nygaard 2003). While nominally smaller, there is no marked size reduction between the northwest Zealand populations and those from Fyn. A reduction in size is observed between roe deer at Agernæs and northwest Zealand and those from northern Germany however, as the deer hunted at Neustadt are larger than those from the two Danish sites. Ultimately, the roe deer from Præstelyng are the smallest, those from northwest Zealand and Fyn are mid-sized, and the largest were hunted at Neustadt. The reasons for this may be due to the smaller home-range sizes required for roe deer (Geist 1998), meaning that the formation of the island of Zealand and subsequent cut-off of contact with other roe deer populations on the mainland probably did not adversely affect the health of the deer on the island in any significant way. However, the small size of the Præstelyng deer remains enigmatic.

Given the size of the red deer coming from populations in northwest Zealand, and in consideration of those hunted at Neustadt, Agernæs and at Præstelyng it is clear that red deer on Zealand overall are smaller than those on the mainland. Deer from northwest Zealand and Præstelyng are markedly smaller than their counterparts on Fyn and in northern Germany. Unlike the roe deer, it does appear that being isolated on an island resulted in a reduction in size, probably owing to any number of factors including less than optimum home ranges and reduced optimum habitats. Still, the deer nearer to the coast in northwest Zealand, while reduced relative to those on the mainland, still appear to be larger than those in the interior. This could be due potentially to overhunting (at sites such as Åkonge and Spangkonge for example), but remains unsubstantiated (Gotfredsen 1998, 2003).

Model

One of the most important findings of this study is the profound regionality of the Ertebølle economy. It is abundantly clear, based on a review of the existing data, that the differences in resource use are not the sole result of the presence or absence of particular species in particular areas, they are due also to real incongruences in the utilization of resources from the environment. Examples of this are the inexplicable rarity of Zealand sites focused on anything other than the big three, despite their presence elsewhere, moderate but important differences in dominance of species as shown in the fish data within and without Zealand, and differences in butchery practices and movement about the environment. Further, similarities seem to be nested, that is, there is a system of overlapping areas where it is possible, and where it is not possible for generalizations to be made. The resulting picture is immeasurably complex, but can be reduced into general statements which are applicable to regions regarding the mammal and bird fauna first, then the fish data. These statements must be considered when applying any comparisons of variability culture-wide. In conjunction with these modifying statements, a general description of an EBK faunal assemblage follows and can be used to assess how much of an actual profound, major change is occurring with the transition to agriculture or within a given area of the EBK.

1)Large game hunting is the rule at most sites. Focused sites which some term, “specialized”, are sites with 80% or less big game and 15% or more of a single non-large-game mammal species or class of species. Nearly all of these sites (Hjerk Nor, Ringkloster, Aggersund, Agernæs, Tybrind Vig, and Vængesø III) are concentrated in the western EBK, and are not found in the eastern EBK. One possible exception is the shell midden at Sølager, which may have been focused on birds. This also explains the inclusion of Aggersund in the list. Aside from Sølager, at which the EBK layers yielding birds were poorly quantified, the eastern EBK is focused only on large game.

2)Roe deer were a far more important resource on Zealand than elsewhere and were a staple on the island. On average, at least one third of mammal assemblages from Zealand are roe deer. In the western EBK this situation is a rarity. Only *Ertebølle* meets this criterion.

3)There is no predictable pattern of roe deer size between major areas of the EBK, as has been suggested elsewhere (Richter and Noe-Nygaard 2003). Size differences are more local, although apparently real (e.g. inland Zealand versus coastal Zealand). This may relate to overhunting or another factor.

4) On Zealand, there is no evidence of selective body-part transport of large game at either coastal or inland sites. On Jutland there is evidence of such transport (Rowley-Conwy 1994-1995). On Fyn, evidence is not well reported, but at Tybrind Vig anecdotal evidence indicates no selective transport (Trolle-Lassen 1990).

5) Wild boar were less important to the economy on Zealand than elsewhere in the EBK .

6) Red deer were more important to the faunal economy on Zealand than elsewhere in the EBK.

7) Certain terrestrial species including wolves, beaver, lynx, badger, polecat, and red squirrels were largely unimportant to EBK hunters.

8) Codfish and flatfish dominate fish assemblages on Zealand, and among them flatfish are more important in northeast Zealand than in northwestern Zealand. Multiple other fish dominate elsewhere in the EBK area.

9) EBK hunters-fishers-gatherers were very capable of acquiring everything that was in their environment.

10) Numbers of bird species are very highly variable, and therefore may not be useful for comparisons throughout the EBK. Of more use are large numbers of particular types of birds, which may indicate specialization.

11) At the so-called “specialized sites”, roe deer hunting is further depressed, except when the target of the specialized hunting strategy is roe deer themselves (e.g. Agernæs).

12) In areas where carbon and nitrogen isotopes show wild species living in similar environments, usage of those species is similar.

13)Sites on Zealand will have around three fewer mammal species than elsewhere due to differential extinction, with aurochs, elk, and the rarer lynx, badger, and polecat not available on the island.

In consideration of these modifying statements, a typical EBK faunal assemblage can be described as follows: The mammal assemblage contains 80% large game, usually red deer, roe deer, with fewer wild boar, 10% fur animals, most likely to be pine marten, and contains a few dogs and seals. Any other species, when found, are usually anectdotal. Bird species may or may not be recovered in large numbers. This may be as dependent on preservation as it is on actual increasing or decreasing abundance. Generally, however, few birds are recovered, yielding an average find of 10 species. There are 14 species of mammal and a wide variety of fish, although one or a few species of fish usually dominate.

Conclusions

Following the above discussion, due to the regional character of how fauna were extracted from the environment, and given what is found at sites in individual regions, any comparative research across the transition is best addressed on a regional level. First, there were resource use differences between the eastern and western Ertebølle including the presence or absence of specialized assemblages, the variable importance of roe deer and wild boar, differential local species extinctions, the dominance of particular species, transport of large-game species, and others factors as outlined above. Second, there were differences between inland and coastal Zealand, including size of animals, the dominance of particular species, and the numbers of species. Third, there were incongruencies between different regions of Zealand, including less variability in western Zealand than eastern Zealand in fish resource use, and differences in flake axe types (Petersen 1994).

Therefore, I suggest that comparative studies of faunal resource use are best applied to regions on the order of approximately 50km in diameter and no larger. This approximates the “territories” of flake axe type first noticed by Petersen (1984). That is, shifts in resource use in an individual region of this size may actually demonstrate true changes in the environment or other factors, and may not be simply a function of inherent regionality in EBK economic activities, although the full character and extent of which is still unknown. The use of fauna in the EBK has both a broad and local character, indicative of not only environmental variability but also cultural variability in how resources were extracted from the environment. How EBK hunters chose their species, how they butchered their species, and which of these activities they chose to perform at a given location seem to have been variable, but predictably so within individual regions. As discussed in the next chapter, this means that when concerning EBK to TRB shifts, in most cases a regional comparison is most appropriate. Unfortunately, this is not possible given the available sample of comparable assemblages. Nonetheless, the expectations as outlined here using data from this research create a baseline for assessing change in the use of faunal resources by Stone Age man in southern Scandinavia.

Final Considerations: Comparing Materials Reported Utilizing Differing Methods

One of the biggest general problems with comparing disperate zooarchaeological assemblages is that there is no real way of assessing to what degree the assemblages being compared were fragmented. Such quantitative data are not recorded. Qualitative data about bone preservation is often available, but contributes little to our understanding of overall fragmentation. However, nonetheless, the degree of fragmentation is perhaps one of the most important influencing factors when it comes to quantitative recording of zooarchaeological data, particularly taxonomic identifications. The only real way of quantifying degree of fragmentation is to measure and assign bones into size classes (Lyman and O'Brienn 1987; Marshall and Pilgram 1993; Outram 2004). Excepting this study, and few other exceptions (Bratlund 1993), such measurements are not done on Mesolithic materials from the region. Therefore, all comparisons made on a broad scale concerning EBK and TRB subsistence carry this caveat: comparisons between sites are viewed through a lens of unknown strength and, therefore the effect on quantitative zooarchaeological statistics is unpredictable.

Fragmentation affects not only identifications; it also has the potential to record differences in individual skeletal-part frequencies. Within red deer, roe deer, and wild boar, the pattern of skeletal part representation is consistent with density-mediated attrition. That is, as fragmentation increases, the more robust elements are better represented than the less-dense ones. As this is the pattern observed when excavation methods are similar, these differences show how important fragmentation generally is on skeletal part frequency, notwithstanding variable excavation and analysis methods.

Fragmentation, or the size of bones in an assemblage can at least in part be attributed to recovery methodology. As discussed above, between sites excavated by the same individual, there probably is little impact of different methods affecting recovery, but among the other sites, there is definite, and probably significant impact, as there are widely different screening strategies used across the years and across researchers (from water-screening to no screening whatsoever). Further, screening is not the only possible methodological difference, as methods of the time when concerning old excavations, excavation strategies, recovery techniques, and other factors surely play a part as well.

While not quantified or quantifiable in this study, assemblages that are not screened at all probably will drop out most of the bones found in the two or three lowest size classes (0-1cm, 1-2cm, and probably 2-3cm) in screened assemblages (Figure 9.1). So, it is the number of bones larger than these classes that are probably more important for overall relative abundance in terms of MNI. These larger bones affect MNI most, so MNI values will probably be less affected between screened and non-screened materials. However, NISP will most certainly be affected to a rather great degree, because effectively there will be far, far fewer loose teeth, smaller carpal or tarsal bones, and the like. Ultimately, NISP is much more affected by recovery technique.

But, it is much, much more common for NISP values to be reported in EBK and TRB faunal assemblages than MNI values. In fact MNI determinations are uncommon. Unfortunately, to understand variability across the EBK and TRB, NISP is probably the only measure that is truly realistic in application in order to have a large-sample, comparative dataset. This, of course, only considers screening and particularly in reference to mammal bone. The recovery of fish remains is highly variable with excavation method, and is not comparable in general between screened and unscreened sites due to the preponderance of very small and fragile elements in fish skeletons.

Chapter 10: Neolithic Synthesis

Introduction

Difficulties have persisted in understanding agricultural origins in southern Scandinavia mainly due to scarce evidence particularly relevant to the earliest farmers in the region. Quite simply, sites yielding potentially useful faunal assemblages from the earliest Neolithic are rare. In the case of available materials, nearly all assemblages are extremely small. An example of this is the handful of cattle bones from the Oxie group ENI settlement on Sprogø in the Storebælt. There are a number of other sites that have yielded numbers of bones in the teens or fewer (Koch 1998; Nielsen 1997). If assemblages with fewer than 500 bones identifiable to species were excluded from analysis, as done in the preceding chapter, the number of faunal assemblages dating exclusively to the ENI TRB would number in the low single digits. Therefore, in order to have enough to actually compare, the minimum sample size for this discussion will be any assemblage with an NISP over 200.

Of course, using sample size as a criterion is a problem (see Chapter 9). A perfect example of this type of problem particular to the TRB sample is the assemblage from Almhov, which although large in size, was most likely an intentional deposit, and may not actually represent evidence of daily subsistence habits in the earliest Neolithic (Macheridis 2011). The adoption of this smaller sample size (N=200) for the Neolithic sites crosses a sample threshold that is probably too small to accurately reflect the numbers of species originally present in the assemblages, as most species in larger assemblages are only represented by few specimens. Therefore, species richness data are not included in this discussion. However, the relative importance of each taxon is still germane.

In all, seven sites from across southern Scandinavia have been reported to contain ENI materials numbering more than 200 bones identifiable to species and probably reflect the subsistence economy (Enghoff 2011; Jonsson 2005; Koch 1998; Noe-Nygaard 1995; Segerberg 1999; Sjögren 2003; Skaarup 1973). These include Anneberg, Havnelev, Karleby Logården, Muldbjerg I, Skumparberget, Sølager, and

Visborg. If mixed-date assemblages from both the EBK and TRB are included with the Havnø data, this number rises to 11 (Chapter 7; Glykou 2011; Gotfredsen 2004a; Heinrich 1999). These include Bodal K, Havnø, Neustadt, and Wangels.

At these sites, as with nearly all EBK analyses, there is usually no mention of how fragmented the bone is, and, in the cases where preservation is addressed, it is usually not quantified. Further problems stem from the profound difficulties differentiating most wild boar from domestic pig and wild auroch from domestic cattle (Chapter 7). In most cases, there is no indication that Neolithic swine or *Bos* sp. can be assumed to be domestic. Furthermore, in terms of wild species, local differences in availability do persist into the Neolithic (Aaris-Sørensen 2009). Therefore, for this discussion, unless specifically described as wild or domestic, all undifferentiated *Sus* sp. and *Bos* sp. are considered as possibly domesticated, with the exception of *Bos* sp. found on Zealand, which must have been domestic.

Problems aside, a dataset does exist which can be used to evaluate how much shift is actually seen in terrestrial faunal use between the EBK and the early TRB. Further, the model of EBK variability presented earlier (Chapter 9), in conjunction with what is known about the early TRB sites that have been investigated, can be used to understand at least part of the degree of shift between the Mesolithic and Neolithic at transitional sites. This is an important consideration in light of the fact that this type of site is a big part of the data that are available. One of the main reasons that transitional assemblages exist, or are presented as such here, is that oftentimes it is exceedingly difficult to separate out all materials stratigraphically. In this case, this means that sometimes the safest approach is to treat them as one, transitional unit.

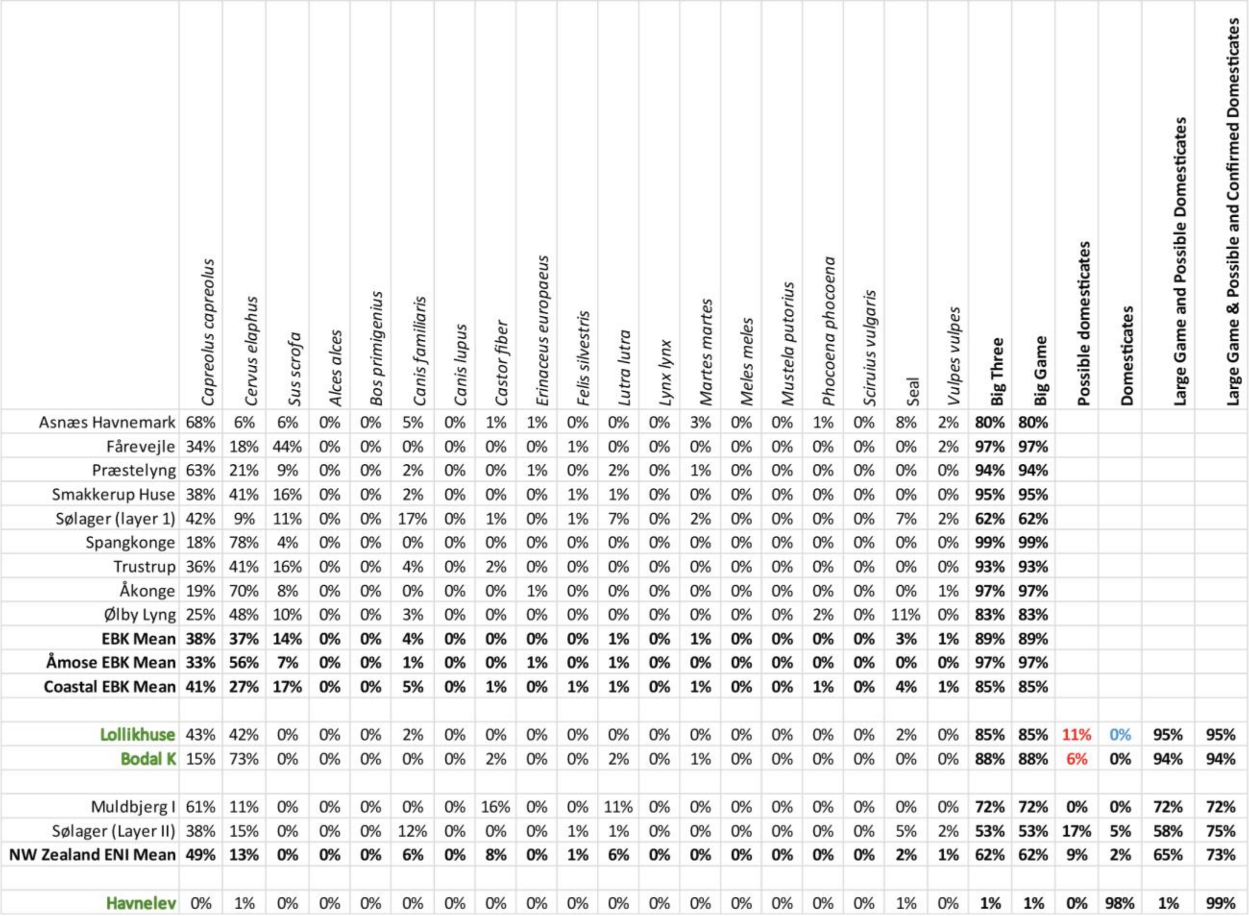
Another issue involves where and when larger assemblages are available for comparison across the transition. As discussed in the previous chapter, 27 larger faunal assemblages that can be attributed to the EBK are available only from southern Scandinavia. Geographically, these are mostly located on Jutland (N=14), Zealand (N=9), and the remainder in Sweden (N=4). When ENI or mixed-date assemblages are considered, the geographic distribution in terms of numbers of sites is in a sense reversed, with useable mixed and exclusively ENI assemblages found predominantly in Sweden (N=3) and Zealand (N=4), two in Germany (N=2), and two on Jutland (N=2). Further complicating matters is the fact that the TRB and EBK had different overall culture areas, so that the sites in Uppland, Sweden, that date to the TRB have no local EBK predecessor. So, comparisons between the EBK and early TRB are inherently skewed. On Jutland 14 sites are being compared with two, one of which is mixed; in Sweden four EBK sites are comparable with three ENI sites from sometimes different regions, and in Germany two mixed sites are compared with no sizeable EBK samples. Therefore, Zealand may present the best opportunity for understanding the transition, given the more comparable sample sizes, but there are reasons why this may be problematic as well. The most glaring problems are the differences in sample-size criteria that I have used: 500 NISP for the EBK sites and 200 NISP for the TRB sites. However, the alternative is to raise or lower these thresholds, which would have resulted in very asymmetric comparison samples, or worse, no comparative sample at all. At best, the following analysis is tentative and incomplete

In describing the transition given data obtained in this dissertation, two regions are of interest; Zealand, given the fact that the EBK sample from before the transition has been bolstered by three sites and Jutland, for which the useable early Neolithic sample has been doubled, albeit by adding a transitional assemblage. Below are two regional discussions of the particularities of comparisons before and across the transition on Zealand and Jutland and second a discussion of similarities between Havnø and Wangels. Third, a general treatment of the evidence for the transition in southern Scandinavia will identify overall trends. Finally, some conclusions about the transition will be made incorporating these new data.

ENI Zealand

Zealand is perhaps the best suited region for study of the transition, due entirely to its somewhat larger numbers of early Neolithic assemblages available for comparisons. This is not to say that it is remotely an adequate sample. In all, three large (>200 NISP) ENI assemblages and one transitional assemblage are available (Table 10.1). The transitional assemblage, Bodal K may very well be best thought-of as TRB, but included here nevertheless as a transitional assemblage as it has provided dates that are both Mesolithic and Neolithic (Gotfredsen 2004a). Lollikhuse is also a potential site with an earliest Neolithic component, but the cattle teeth recovered are controversial (see Noe-Nygaard et al. 2005), and most of the material is EBK. Therefore, it is mentioned but not further considered.

The picture remains extremely incomplete. Of import is the fact that the only truly transitional site containing separable occupation layers from the EBK and TRB from the region is the shell midden at Sølager. At that site, it is apparent that the collection of seabirds is a major activity in EBK and TRB layers (Skaarup 1973). As discussed previously (Chapter 9), particularly in reference to birds in EBK contexts, such species are oftentimes poorly quantified, poorly preserved, or subject to any number of factors which have the potential to limit interpretability in a comparative sense. Ultimately, it is difficult to relate the significance of bird use at these sites relative to other resources due to differences in recording rigor. This is the case at Sølager. Therefore, a consideration of the differences between the Mesolithic economies of Zealand as a whole with the Neolithic economy on Sølager in conjunction with early Neolithic sites in the Åmose and one near Præstøfjord is in no way a representative picture across the transition, as much of the EBK sample is coastal. Nevertheless, some conclusions may be drawn.



	Capreolus capreolus	*Cervus elaphus*	*Sus scrofa*	*Alces alces*	*Bos primigenius*	*Canis familiaris*	*Canis lupus*	*Castor fiber*	*Erinaceus europaeus*	*Felis silvestris*	*Lutra lutra*	*Lynx lynx*	*Martes martes*	*Meles meles*	*Mustela putorius*	*Phocoena phocoena*	*Sciruius vulgaris*	Seal	*Vulpes vulpes*	**Big Three**	**Big Game**	**Possible domesticates**	**Domesticates**	**Large Game and Possible Domesticates**	**Large Game & Possible and Confirmed Domesticates**
Asnæs Havnemark	68%	6%	6%	0%	0%	5%	0%	1%	1%	0%	0%	0%	3%	0%	0%	1%	0%	8%	2%	**80%**	**80%**				
Fårevejle	34%	18%	44%	0%	0%	0%	0%	0%	0%	1%	0%	0%	0%	0%	0%	0%	0%	0%	2%	**97%**	**97%**				
Præstelyng	63%	21%	9%	0%	0%	2%	0%	0%	1%	0%	2%	0%	1%	0%	0%	0%	0%	0%	0%	**94%**	**94%**				
Smakkerup Huse	38%	41%	16%	0%	0%	2%	0%	0%	0%	1%	1%	0%	0%	0%	0%	0%	0%	0%	0%	**95%**	**95%**				
Sølager (layer 1)	42%	9%	11%	0%	0%	17%	0%	1%	0%	1%	7%	0%	2%	0%	0%	0%	0%	7%	2%	**62%**	**62%**				
Spangkonge	18%	78%	4%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	**99%**	**99%**				
Trustrup	36%	41%	16%	0%	0%	4%	0%	2%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	**93%**	**93%**				
Åkonge	19%	70%	8%	0%	0%	0%	0%	0%	1%	0%	0%	0%	0%	0%	0%	0%	0%	0%	1%	**97%**	**97%**				
Ølby Lyng	25%	48%	10%	0%	0%	3%	0%	0%	0%	0%	0%	0%	0%	0%	0%	2%	0%	11%	0%	**83%**	**83%**				
EBK Mean	**38%**	**37%**	**14%**	**0%**	**0%**	**4%**	**0%**	**0%**	**0%**	**0%**	**1%**	**0%**	**1%**	**0%**	**0%**	**0%**	**0%**	**3%**	**1%**	**89%**	**89%**				
Åmose EBK Mean	**33%**	**56%**	**7%**	**0%**	**0%**	**1%**	**0%**	**0%**	**1%**	**0%**	**1%**	**0%**	**0%**	**0%**	**0%**	**0%**	**0%**	**0%**	**0%**	**97%**	**97%**				
Coastal EBK Mean	**41%**	**27%**	**17%**	**0%**	**0%**	**5%**	**0%**	**1%**	**0%**	**1%**	**1%**	**0%**	**1%**	**0%**	**0%**	**1%**	**0%**	**4%**	**1%**	**85%**	**85%**				
Lollikhuse	43%	42%	0%	0%	0%	2%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	2%	0%	**85%**	**85%**	**11%**	0%	**95%**	**95%**
Bodal K	15%	73%	0%	0%	0%	0%	0%	2%	0%	0%	2%	0%	1%	0%	0%	0%	0%	0%	0%	**88%**	**88%**	**6%**	**0%**	**94%**	**94%**
Muldbjerg I	61%	11%	0%	0%	0%	0%	0%	16%	0%	0%	11%	0%	0%	0%	0%	0%	0%	0%	0%	**72%**	**72%**	**0%**	**0%**	**72%**	**72%**
Sølager (Layer II)	38%	15%	0%	0%	0%	12%	0%	0%	0%	1%	1%	0%	0%	0%	0%	0%	0%	5%	2%	**53%**	**53%**	**17%**	**5%**	**58%**	**75%**
NW Zealand ENI Mean	**49%**	**13%**	**0%**	**0%**	**0%**	**6%**	**0%**	**8%**	**0%**	**1%**	**6%**	**0%**	**0%**	**0%**	**0%**	**0%**	**0%**	**2%**	**1%**	**62%**	**62%**	**9%**	**2%**	**65%**	**73%**
Havnelev	0%	1%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	1%	0%	**1%**	**1%**	**0%**	**98%**	**1%**	**99%**

Table 10.1: The Mesolithic-Neolithic transition on Zealand (Lollikhuse, Bodal K and Havnelev are displayed in green because they are transitional, or are located outside of northwest Zealand. Red indicates animals that are almost certainly wild, and blue omits debated specimens)

The degree of Neolithization between Havnelev and the sites in the Åmose along with Sølager are dissimilar in the earliest Neolithic concerning the importance of domesticated animals. Havnelev is completely dominated by domesticated species, while the Åmose sites and Sølager at best have simply the presence of few domesticates. One explanatory option is that Havnelev represents a settlement site, and the others are the catching sites so often mentioned for eastern Jutland (Madsen 1982; Madsen and Juul 1982; Johansen 2006). If this is the case, then the pattern holds for Zealand as well, with a sort of transitional period in which significant hunting and gathering way of life continued for a time, and at another, separate type of site, people were actually living with all of their domestic animals. Another option is that neolithization is happening at a different pace in each individual region, and that agriculture "arrives" earlier for some regions than for others. There actually is no reason to expect that this could not be at least partially the case, as it has already been shown that the TRB appears somewhat earlier in northern Germany than in Denmark (Hartz et al. 2007). However, neither of these scenarios can be convincingly demonstrated.

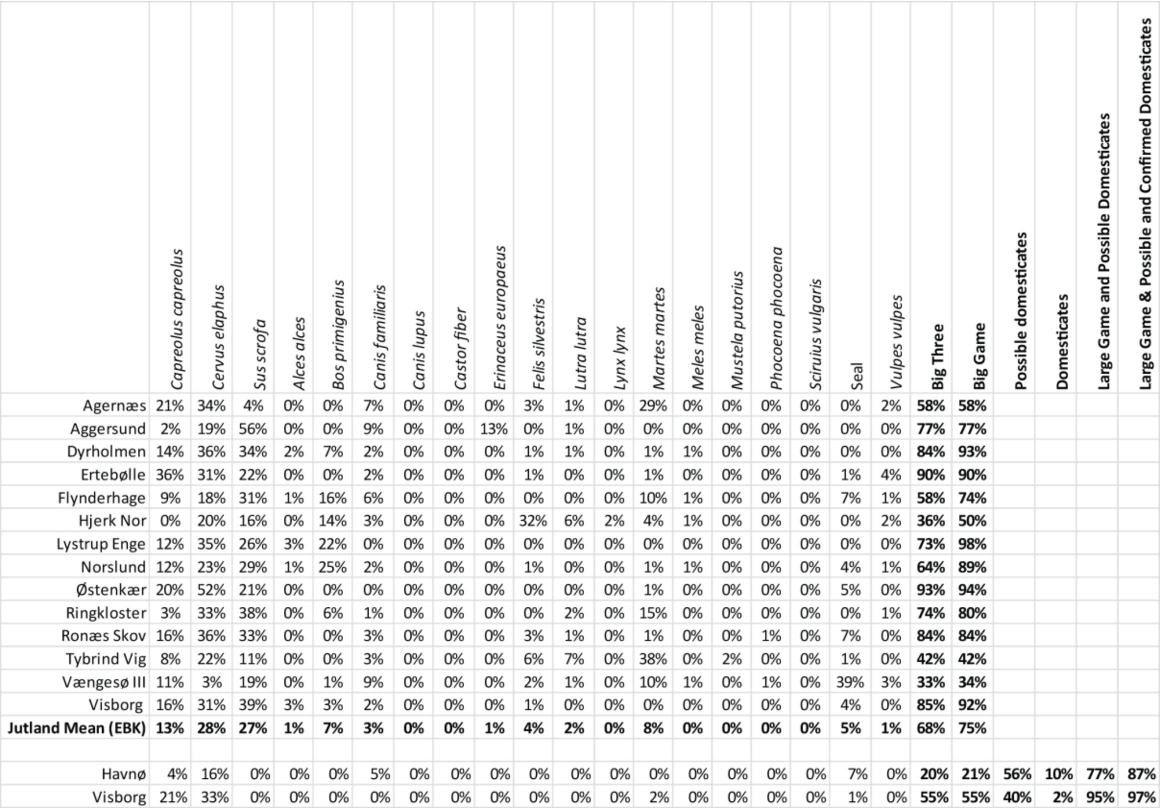
An alternate scenario is that on the island of Zealand, economic Neolithization is an ongoing regional process in the earliest ENI. This means that regions could have adopted a predominantly domesticate-based way-of-life sequentially, and not necessarily concurrently, and that this adoption involved not only a change from hunting wild prey to utilizing domestic species, but also shifts in the wild prey that were being hunted in some cases as well. Of course, this is not to say that this was a slow adoption process, but may lend insight into the mechanisms of such a scenario. The existing faunal evidence, albeit extremely small, does not entirely disagree with this alternate explanation. First, there is actually more variability among hunting and gathering activities between Muldbjerg I, and Sølager in the ENI than among the much larger sample late EBK on Zealand. Second, domestic animal remains are extremely rare at these sites. Also, the relative rarity of *Sus* sp. at EBK and early TRB sites on Zealand indicates that substantial husbandry of this species is probably absent. Finally, the local extinction of aurochs prior to the transition increases the certainty of the arrival of domestic cattle (Aaris-Sørensen 2009).

Muldbjerg I yielded overwhelmingly wild species, with only very few specimens attributable to domestic taxa (Noe-Nygaard 1995). When compared to the model established in the previous chapter, and the nearby EBK sites in the Åmose, we have a situation where there is little change from the EBK at Muldbjerg I in terms of Neolithization or evidence of significant husbandry of domesticated animals. In fact, Muldbjerg I falls outside of the normal range of regional variability for the entire EBK on Zealand (Chapter 7), as fur mammals at the site comprise over a quarter of the faunal material, meeting the criteria of a focused site. I question why this is first seen in the Neolithic and not in the preceding Mesolithic on the island of Zealand. As discussed in the previous chapter, prior to the transition, no focused sites for fur mammals had been observed previously on the island.

Very few swine are seen in the Åmose in general, both in the Mesolithic and Neolithic, and at the Neolithic sites in the Åmose, neither are cattle. This may indicate that the first cattle are being brought in via low-lying coastal areas and not through the interior (see Noe-Nygaard et. al. 2005). It also may mean that domestic pig was similarly brought in on the same route. Otherwise, one would expect to see some change in inland pig use. In fact, the two Åmose ENI sites have nearly the same or *fewer* swine than in the preceeding EBK. Given the fact that *Bos* congeners and very few *Sus* congeners were present in the Åmose prior to and after the introduction of animal husbandry, Bodal K and Muldbjerg really do reflect a lack of these species at these sites. This eliminates the ambiguity seen at sites like Havnø or Wangels (Chapter 7; Heinrich 1999). This reinforces the interpretation that the presence of actual animal husbandry at the coast, and not just visits to catchments may be a real possibility. It also raises questions about the evenness of the quick spread of agriculture to Denmark and the nature of the adoption, given the atypical contemporary wild animal use. Ultimately, the Zealand case points to the necessity for regional studies of variability when understanding the transition to agriculture. Muldbjerg I, if placed in eastern Jutland, would be completely typical for an EBK site and probably not too surprising an assemblage for an ENI catching site. However, in context with what is known about the Zealand-specific EBK, it is more remarkable.

The EBK Model, Havnø, Visborg, and Jutland

Despite the lack of separation between the Mesolithic and Neolithic sample from Havnø, it may be productive to compare what is usually found at EBK sites in the region to the Havnø material alone. In Table 10.2, the Havnø assemblage is compared with all EBK assemblages larger than 500 bone specimens attributable to species from Jutland. Comparable TRB assemblages from Jutland in particular are extremely limited in scope, with reasonable sample sizes (e.g. >200 bone specimens attributable to species) limited to just Havnø and Visborg along the Mariager fjord. Neolithic layers are reported elsewhere (Bjørnsholm and Norsminde, for example) but these are extremely small and probably are not representative (Andersen 1989; Bratlund 1993). The two shell middens are located approximately 5km from each-other, and were separated by water during the Stone Age, with Havnø located on an island, and Visborg located on the nearest mainland coast (Andersen 2008). The picture obtained from the EBK data, Visborg and Havnø shows the penchant for high variability in the use of resources in the early Neolithic, even at locations that are very near to one-another and of the same general site-type. They also demonstrate a major shift at Havnø from the Mesolithic to Neolithic.



	Capreolus capreolus	*Cervus elaphus*	*Sus scrofa*	*Alces alces*	*Bos primigenius*	*Canis familiaris*	*Canis lupus*	*Castor fiber*	*Erinaceus europaeus*	*Felis silvestris*	*Lutra lutra*	*Lynx lynx*	*Martes martes*	*Meles meles*	*Mustela putorius*	*Phocoena phocoena*	*Sciruius vulgaris*	Seal	*Vulpes vulpes*	**Big Three**	**Big Game**	**Possible domesticates**	**Domesticates**	**Large Game and Possible Domesticates**	**Large Game & Possible and Confirmed Domesticates**
Agernæs	21%	34%	4%	0%	0%	7%	0%	0%	0%	3%	1%	0%	29%	0%	0%	0%	0%	0%	2%	**58%**	**58%**				
Aggersund	2%	19%	56%	0%	0%	9%	0%	0%	13%	0%	1%	0%	0%	0%	0%	0%	0%	0%	0%	**77%**	**77%**				
Dyrholmen	14%	36%	34%	2%	7%	2%	0%	0%	0%	1%	1%	0%	1%	1%	0%	0%	0%	0%	0%	**84%**	**93%**				
Ertebølle	36%	31%	22%	0%	0%	2%	0%	0%	0%	1%	0%	0%	1%	0%	0%	0%	0%	1%	4%	**90%**	**90%**				
Flynderhage	9%	18%	31%	1%	16%	6%	0%	0%	0%	0%	0%	0%	10%	1%	0%	0%	0%	7%	1%	**58%**	**74%**				
Hjerk Nor	0%	20%	16%	0%	14%	3%	0%	0%	0%	32%	6%	2%	4%	1%	0%	0%	0%	0%	2%	**36%**	**50%**				
Lystrup Enge	12%	35%	26%	3%	22%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	**73%**	**98%**				
Norslund	12%	23%	29%	1%	25%	2%	0%	0%	0%	1%	0%	0%	1%	1%	0%	0%	0%	4%	1%	**64%**	**89%**				
Østenkær	20%	52%	21%	0%	0%	0%	0%	0%	0%	0%	0%	0%	1%	0%	0%	0%	0%	5%	0%	**93%**	**94%**				
Ringkloster	3%	33%	38%	0%	6%	1%	0%	0%	0%	0%	2%	0%	15%	0%	0%	0%	0%	0%	1%	**74%**	**80%**				
Ronæs Skov	16%	36%	33%	0%	0%	3%	0%	0%	0%	3%	1%	0%	1%	0%	0%	1%	0%	7%	0%	**84%**	**84%**				
Tybrind Vig	8%	22%	11%	0%	0%	3%	0%	0%	0%	6%	7%	0%	38%	0%	2%	0%	0%	1%	0%	**42%**	**42%**				
Vængesø III	11%	3%	19%	0%	1%	9%	0%	0%	0%	2%	1%	0%	10%	1%	0%	1%	0%	39%	3%	**33%**	**34%**				
Visborg	16%	31%	39%	3%	3%	2%	0%	0%	0%	1%	0%	0%	0%	0%	0%	0%	0%	4%	0%	**85%**	**92%**				
Jutland Mean (EBK)	**13%**	**28%**	**27%**	**1%**	**7%**	**3%**	**0%**	**0%**	**1%**	**4%**	**2%**	**0%**	**8%**	**0%**	**0%**	**0%**	**0%**	**5%**	**1%**	**68%**	**75%**				
Havnø	4%	16%	0%	0%	0%	5%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	7%	0%	**20%**	**21%**	**56%**	**10%**	**77%**	**87%**
Visborg	21%	33%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	2%	0%	0%	0%	0%	1%	0%	**55%**	**55%**	**40%**	**2%**	**95%**	**97%**

Table 10.2: The Havnø assemblage and the TRB Visborg assemblage versus the EBK on Jutland

The domesticated animal component of the Havnø assemblage shows a significant economic reorganization between the Mesolithic and Neolithic at the site even though the two phases have not been separated. At the very least, around 10% of the material from Havnø can be confidently attributed to domestic species. Even with the inability to differentiate middle and late Stone Age components, this represents a significant departure from any part of the Ertebølle in the region. In this regard, a major departure from the EBK economy at Havnø is certain to have occurred at the start of the TRB. Then too, at the site and even though grouped, the occurrence of both red and roe deer is markedly depressed in comparison to Mesolithic averages from all regions. This can only be attributed to the local environment and its presumable lack of large stocks of these species as it was an island. In fact, the use of roe deer can at best be referred to as a very minor component of the economy. They are less important than even seals at the site.

The complex stratigraphy at Visborg has been separated partially between Mesolithic and Neolithic components, allowing a comparison between the two time periods (Table 10.2). Differences between the Mesolithic and Neolithic levels have been interpreted to mean that there is a gradual adoption of an agricultural way of life in the region, as a persistence of wild animals is clearly evident into the Neolithic with the inclusion of just a few domesticates (Enghoff 2011). Given the unresolved stratigraphy, at present it is inadvisable and, indeed impossible, to separate out the entire Mesolithic and Neolithic components at Havnø, and therefore data from Visborg may lend some insight into how to interpret the combined assemblage.

	N=	*Capreolus capreolus*	*Cervus elaphus*	*Sus scrofa*	*Alces alces*	*Bos primigenius*	*Canis familiaris*	*Castor fiber*	*Felis silvestris*	*Lutra lutra*	*Martes martes*	Seal	*Vulpes vulpes*	**Possible domesticates**	**Domesticates**	**Large Game**	**Large Game and Possible Domesticates**	**Large Game & Possible and Confirmed Domesticates**
Visborg (Mesolithic)	654	16%	31%	39%	3%	3%	2%	0%	1%	0%	0%	4%	0%	0%	0%	92%	92%	92%
Visborg (Neolithic)	239	21%	33%	0%	0%	0%	0%	0%	0%	0%	2%	1%	0%	40%	2%	55%	95%	97%
Visborg (All)	1007	16%	31%	25%	2%	2%	3%	0%	1%	0%	1%	4%	0%	13%	1%	76%	89%	90%
Havnø (All)	1187	4%	16%	0%	0%	0%	5%	0%	0%	0%	0%	7%	0%	56%	10%	21%	77%	87%

Table 10.3: Visborg assemblage by level in comparison with Havnø

There are several key differences between the two sites (Table 10.3). First, only a few bird bones were attributed to species at Visborg (N=16), and at Havnø, aquatic waterfowl must have made up a significant resource at the site. *Individuals* of velvet scoter (N=21) at Havnø outnumber the total bones attributed to species at Visborg. This species, in conjunction with swans represents a major resource of much lesser or no significance at Visborg. Second, and perhaps more important is the presence in the assemblage of ovicaprids in numbers that are highly unusual for an early Neolithic shell midden. One assumption that can be made is that the ovicaprids are definitely Neolithic in age (and confirmed as such via AMS), without the complications resulting from problematic identifications with wild congeners such as *Bos* sp. and swine. This is because there are no wild ovicaprids in Denmark. Third, nearly one-quarter of the faunal material from Havnø is of the genus *Bos* (Table 10.3). While only 12 specimens could be attributed confidently to domestic cow, and aurochs are definitely present in the assemblage as recorded by the single auroch specimen, a significant number of the *Bos* remains, given their size, are almost certainly domestic cow. However, this is not provable as appropriate measurements could not be taken in most cases. While it is not an impossible situation (see Andersen and Malmros 1966) to have an assemblage that is nearly one-fourth aurochs in EBK contexts, the likelihood that all of the remaining *Bos* specimens are even a plurality of aurochs remains highly unlikely, particularly since so few aurochs are present in the Visborg assemblage. This is even more unlikely because Havnø was a small island, very unlikely to have harbored any significant populations of such a large animal, as evidenced by the relative paucity of deer. Of course, such specimens could have been hunted elsewhere and transported to the island, although this scenario is not plausible given the rarity of aurochs at contemporary Visborg, lying nearly on the closest mainland shore from the island. It is not unthinkable that the majority of the *Bos* species from the site are, in fact, domestic animals.

So, even if one is very conservative and assigns one-half of the *Bos* specimens as domestic cattle, and none of the *Sus* specimens as domestic, when combined with the sheep and goats one is confronted with a mixed Mesolithic and Neolithic assemblage which is just short of one-quarter domestic animals, almost all certainly early Neolithic in date, four of which having been AMS dated to the ENI (Chapter 7). To continue, if one is extremely conservative and assumes all of the undetermined congeners are wild specimens, at least 10% of the material is domestic. This sample contains *Mesolithic material as well.* Further, in all probability, some of the swine specimens are likely domestic, given their dietary habits as discussed in Chapter 8. They are eating the same foods as contemporary wild deer and domestic cattle, a situation not typical for wild boar (Chapter 7). Finally, there is some evidence that cattle are being raised near to the island and not moved to the coast seasonally because a single 3rd Phalanx of a very young calf was recovered, and indicates its birth near or at the site.

In all, one cannot speak of the site without insisting that what the island probably represents is not a seasonal early Neolithic hunting camp that farmers are travelling to in order to pursue a Mesolithic-like hunting strategy. Some permutation of actual Neolithic farming activities was occurring at the coast. As the wild species show, the focus of the economy at Havnø was already dissimilar to that at Visborg even during the Mesolithic. This difference persists into the Neolithic as well, albeit in different form. Naturally, it is not unthinkable for the coast to have been a fine place to raise domestic species. In particular, there may have been extensive coastal grasslands available for the foddering of these animals, a probability hinted at elsewhere in previous studies (Noe-Nygaard et al. 2005).

This interpretation of Havnø is in direct contrast to some scholars' views of how transitional middens, and indeed the coast, were utilized during the early Neolithic. Two site types are described, catching sites and settlement sites, the former containing mostly wild resources and the latter reliant on domestic crops and animals (Johansen 2006). In fact, some scholars argue that Neolithic layers at shell middens no longer represent settlements as they were in the last EBK (Johansen 2006). However, Havnø shows that certain locations may have performed both catching and residential sites' functions. Given the predictions of Madsen (1982), further discussed in Madsen and Juul (1982) as to where settlement sites should be located, it is not unreasonable to think that Havnø may have been as advantageous a location for a Mesolithic hunting camp as it would have been for an early farming settlement. Following this, when discussing eastern Jutland specifically, ENI settlement sites are close to the coast, often within three kilometers where they have been investigated (Madsen and Juul 1982). Therefore, there is no reason to suppose that this may not have been the case at Havnø.

Some scholars have also noticed that there is little evidence for the overwhelming contribution of agricultural activity to the economy in the ENI. This continues until the subsequent ENII, when agricultural activities and settlement become more visible (Jensen 1996; Price et al 1995; Price and Noe-Nygaard 2009). It is also argued that widespread forest clearance is not evident until the Middle Neolithic (Andersen 1992). As discussed earlier, reported settlement site faunal assemblages are extremely small and indicate the presence of domesticates (Møhl 1975; Nielsen 1985; Nielsen 1997). As for ENI catching sites, almost all data come from coastal "køkkenmøddinger" with EBK and early TRB occupations. This is the case at Bjørnsholm, Norsminde, Visborg, and Sølager, although there is an inland catching site at Muldbjerg I and a transitional non-midden site at Wangels, in northern Germany (Andersen 1991, 1993, 1998; Bratlund 1993; Hartz et al 2002; Noe-Nygaard 1995; Skaarup 1973). All of these sites have a predominance of wild game. The view presented here concerning Havnø is that regardless of how the assemblage is eventually chronologically separated between Mesolithic and Neolithic components, the available evidence indicates significant husbandry at the site in the early Neolithic, strong differences in wild and domestic resource use with nearby Visborg, and the possibility of the continuous use of Havnø from the Mesolithic until the end of the ENI in the region, given the new AMS dates.

Comparison with Wangels

The clearest analog with the assemblage from Havnø is Wangels, located in northern Germany. Wangels, while transitional, has a large Neolithic component, in which substantial numbers of domesticated species are identified (Heinrich 1999). The two assemblages, when compared side-by-side, exhibit extensive similarities (Table 10.4). In particular, the similarly low numbers of red deer, roe deer, and other species are marked. Some discrepancies may come from analytical methodologies or the nature of the assemblages themselves. I have included all *Sus* sp. and *Bos* sp. as possibly domesticated, whereas Heinrich (1999) attributed or was able to attribute many of these specimens to either wild or domestic classes. Many of the *Sus* sp. I have included as possibly domesticated may have been wild boar, but ultimately both sites have similar extents of large game and possible and confirmed domesticates. These similarities may hint that processes of agricultural adoption may also have been similar in eastern Jutland and northern Germany. While I have been more cautious in identifying swine as domestic, the significant numbers of domesticates among the Havnø assemblage point to a similar situation as that at Wangels, in which substantial introduction of domestic species is present in the earliest Neolithic.

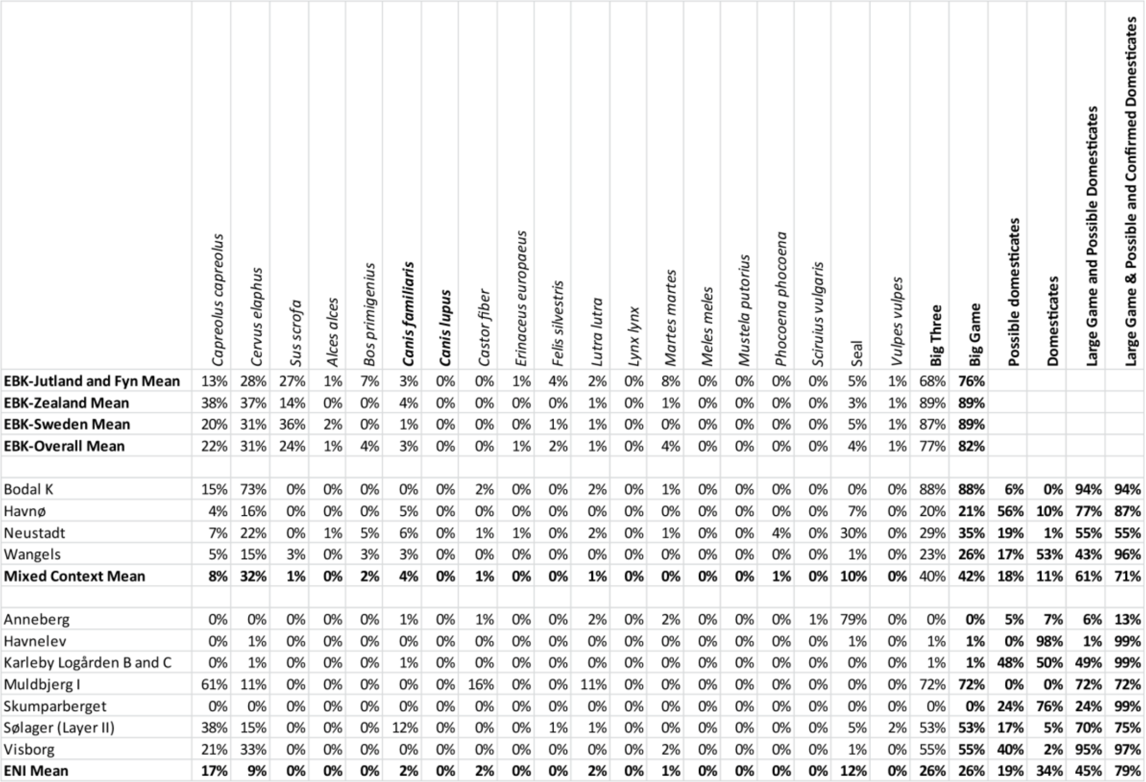
	Capreolus capreolus	*Cervus elaphus*	*Sus scrofa*	*Alces alces*	*Bos primigenius*	*Canis familiaris*	*Canis lupus*	*Castor fiber*	*Erinaceus europaeus*	*Felis silvestris*	*Lutra lutra*	*Lynx lynx*	*Martes martes*	*Meles meles*	*Mustela putorius*	*Phocoena phocoena*	*Sciruius vulgaris*	Seal	*Vulpes vulpes*	**Big Three**	**Big Game**	**Possible domesticates**	**Domesticates**	**Large Game and Possible Domesticates**	**Large Game & Possible and Confirmed Domesticates**
Havnø	4%	16%	0%	0%	0%	5%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	7%	0%	**20%**	**21%**	**56%**	**10%**	**77%**	**87%**
Wangels	5%	15%	3%	0%	3%	3%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	1%	0%	**23%**	**26%**	**17%**	**53%**	**43%**	**96%**

Table 10.4: The assemblages from Havnø and Wangels

The Transition in Southern Scandinavia

Table 10.5 shows the overall averaged relative abundance data from the EBK, mixed EBK/TRB assemblages, and confidently ENI assemblages from across southern Scandinavia. Region-wide, there are only six ENI assemblages that may indicate the actual abundance of individual taxa, classes of species, or types of species concerning the difference between the latest EBK and the earliest TRB. The big problem with using the sample from eastern Sweden is that most of the reported sites come from Uppland, a region where the EBK did not exist. Therefore, a true comparison with EBK variability is not directly applicable. However, the east Sweden example is extremely interesting as there is a dichotomy of sites, those that face the water and those that face the land, and that there are profound differences between the fauna that are found at those sites (Hallgren 1998; Segerberg 1999).

Despite being contemporary, culturally similar, and geographically near to each-other, Anneberg is absolutely dominated by seals and seal hunting, and Skumparberget is absolutely dominated by domesticated animals (Hallgren 1998; Segerberg 1999). While not discussed here, sites with smaller samples in this region in eastern Sweden also support this dichotomy (Hallgren 1998; Segerberg 1999). Hallgren (1998) argues that the hunting of wild animals, particularly seals, has to do with a collective memory of the previous, Mesolithic way of life, while at the same time the society is completely Neolithic, as evidenced by the culturally similar and entirely domesticate-focused sites such as Skumparberget. While many miles away from the EBK, the degree of seal hunting in the sea-facing sites is unknown in EBK contexts and therefore represents a major difference moving into the Neolithic. The only assemblage from the EBK sample discussed here that has any sort of wide-scale sealing is Vængesø III, where under 40% of the assemblage is due to this activity. From a Mesolithic standpoint concerning EBK subsistence strategies, Anneberg is highly unusual, and along with its companion sites for sealing that are nearby (Hallgren 1998; Segerberg 1999) actually does represent a major shift between the EBK and the Neolithic, despite a continued use of wild resources and the geographic separation. The point is, the Mesolithic to Neolithic shift must not mean necessarily a shift in all cases from wild to domestic forms, but can be a more complicated situation.



	Capreolus capreolus	*Cervus elaphus*	*Sus scrofa*	*Alces alces*	*Bos primigenius*	***Canis familiaris***	***Canis lupus***	*Castor fiber*	*Erinaceus europaeus*	*Felis silvestris*	*Lutra lutra*	*Lynx lynx*	*Martes martes*	*Meles meles*	*Mustela putorius*	*Phocoena phocoena*	*Sciruius vulgaris*	Seal	*Vulpes vulpes*	**Big Three**	**Big Game**	**Possible domesticates**	**Domesticates**	**Large Game and Possible Domesticates**	**Large Game & Possible and Confirmed Domesticates**
EBK-Jutland and Fyn Mean	13%	28%	27%	1%	7%	3%	0%	0%	1%	4%	2%	0%	8%	0%	0%	0%	0%	5%	1%	68%	**76%**				
EBK-Zealand Mean	38%	37%	14%	0%	0%	4%	0%	0%	0%	0%	1%	0%	1%	0%	0%	0%	0%	3%	1%	89%	**89%**				
EBK-Sweden Mean	20%	31%	36%	2%	0%	1%	0%	0%	0%	1%	1%	0%	0%	0%	0%	0%	0%	5%	1%	87%	**89%**				
EBK-Overall Mean	22%	31%	24%	1%	4%	3%	0%	0%	1%	2%	1%	0%	4%	0%	0%	0%	0%	4%	1%	77%	**82%**				
Bodal K	15%	73%	0%	0%	0%	0%	0%	2%	0%	0%	2%	0%	1%	0%	0%	0%	0%	0%	0%	88%	**88%**	**6%**	**0%**	**94%**	**94%**
Havnø	4%	16%	0%	0%	0%	5%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	7%	0%	20%	**21%**	**56%**	**10%**	**77%**	**87%**
Neustadt	7%	22%	0%	1%	5%	6%	0%	1%	1%	0%	2%	0%	1%	0%	0%	4%	0%	30%	0%	29%	**35%**	**19%**	**1%**	**55%**	**55%**
Wangels	5%	15%	3%	0%	3%	3%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	1%	0%	23%	**26%**	**17%**	**53%**	**43%**	**96%**
Mixed Context Mean	**8%**	**32%**	**1%**	**0%**	**2%**	**4%**	**0%**	**1%**	**0%**	**0%**	**1%**	**0%**	**0%**	**0%**	**0%**	**1%**	**0%**	**10%**	**0%**	40%	**42%**	**18%**	**11%**	**61%**	**71%**
Anneberg	0%	0%	0%	0%	0%	1%	0%	1%	0%	0%	2%	0%	2%	0%	0%	0%	1%	79%	0%	0%	**0%**	**5%**	**7%**	**6%**	**13%**
Havnelev	0%	1%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	1%	0%	1%	**1%**	**0%**	**98%**	**1%**	**99%**
Karleby Logården B and C	0%	1%	0%	0%	0%	1%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	1%	**1%**	**48%**	**50%**	**49%**	**99%**
Muldbjerg I	61%	11%	0%	0%	0%	0%	0%	16%	0%	0%	11%	0%	0%	0%	0%	0%	0%	0%	0%	72%	**72%**	**0%**	**0%**	**72%**	**72%**
Skumparberget	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	**0%**	**24%**	**76%**	**24%**	**99%**
Sølager (Layer II)	38%	15%	0%	0%	0%	12%	0%	0%	0%	1%	1%	0%	0%	0%	0%	0%	0%	5%	2%	53%	**53%**	**17%**	**5%**	**70%**	**75%**
Visborg	21%	33%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	2%	0%	0%	0%	0%	1%	0%	55%	**55%**	**40%**	**2%**	**95%**	**97%**
ENI Mean	**17%**	**9%**	**0%**	**0%**	**0%**	**2%**	**0%**	**2%**	**0%**	**0%**	**2%**	**0%**	**1%**	**0%**	**0%**	**0%**	**0%**	**12%**	**0%**	**26%**	**26%**	**19%**	**34%**	**45%**	**79%**

Table 10.5: EBK averages, EBK-TRB mixed-context assemblages, and ENI assemblages from southern Scandinavia

Essentially, the comparison-appropriate sample in order to understand the earliest farming economies outside of east Sweden rests on single or pairs of sites that have clear and unambiguously ENI dates or mixed occupation layers. The only good evidence of a farming settlement in western Sweden is Karleby Logården (Sjögren 2003), where the assemblage is nearly entirely domestic animals. However, the exact sort of system this may have been indicative of is unclear. While the possibility exists that such a dichotomous system as is seen in eastern Sweden may exist in west Sweden as well, there is no evidence of the other half of the system, if it was present.

Havnelev, located in southeastern Zealand near the Præstø Fjord, is another example of an ENI assemblage dominated by domesticates (Koch 1998). However, its location is problematic because it is some distance from nearly all of the studied sites on the island, most of which are in the northwestern part or the Åmose. There are no representative samples of EBK assemblages from closer environs. Depending on whether or not the process of neolithization is a local or regional process, this can have great importance due to regional differences in artifact types between these regions in the EBK (Petersen 1984). Notwithstanding, Havnelev represents the only sizeable Danish collection of nearly entirely domestic species dated to the ENI. This is in contrast to all other earliest Neolithic assemblages from Denmark under discussion here.

Geographically, the next early Neolithic or partly Neolithic sites are Bodal K and Muldbjerg I, both located in the Åmose (Gotfredsen 2004a; Noe-Nygaard 1995). These sites are both notable for their absolute dominance of wild species. While chronologically Neolithic, there is nothing at these sites that indicates any substantial reliance on domestic plants and animals. Specifically, Bodal K is very similar to the other Åmose sites which are dominated by red deer, and certainly does not represent a major shift at this earliest chronological phase of the Neolithic (Gotfredsen 1998; 2003; 2004a). Muldbjerg I is also chronologically early Neolithic in age, and is particularly interesting due to its very high representation for Zealand of fur animals, particularly beaver (Noe-Nygaard 1995). The assemblage is over one quarter fur animals, a degree of representation that places the site closer in nature to some of the so-called specialized EBK sites elsewhere, particularly Jutland. This is highly atypical. I argue that in light of the variability observed in the EBK on Zealand, particularly the nearly complete lack of sites specialized for anything other than the big three, Muldbjerg I and its reliance on fur animals represents a major break with the Mesolithic pattern in the region. That is, the site may represent a different kind of shift in the early Neolithic, one that involves only wild resources. This is not an unreasonable interpretation given the dichotomous situation occurring in eastern Sweden. However, the causes for such a shift or reorganization of strategies that this might indicate are complete conjecture at this point.

Lollikhuse may have a brief Neolithic component, but dating doubts about the species identification of early cattle from the site persist despite the possibility of introduction starting around 4600 B.C. (Noe-Nygaard et al. 2005). Therefore, it will be considered to be simply a Mesolithic occupation. Sølager is the only other site on Zealand to yield fauna in numbers that are interpretable with a clearly separated ENI component. All evidence at the Sølager midden indicates a TRB continuation of the Mesolithic faunal economy, including the focus on birds, with the single caveat that there are few domestic animals present. So, the extremely limited sample from Zealand indicates three traits of the earliest Neolithic: 1)locations where a continuation of the Mesolithic economy is in evidence with the low inclusion or lack of inclusion of domestic animals, 2)locations where farming, or at least animal husbandry, is the main activity, and 3)locations that may represent a shift from the late Mesolithic economy to a new type of Neolithic wild-resource based economy.

Larger, more interpretable assemblages from Jutland are rarer still, and are limited to a single assemblage with a reasonably large sample size, Visborg (Enghoff 2011). Other ENI assemblages from Jutland exist (Andersen 1989; Bratlund 1993), but their small sample sizes permit only the limited interpretations that they are still mostly wild animals with some domesticates. The Visborg material is discussed above, but the general impression is a continuation of the Mesolithic way of life, with few domesticates in the ENI. However, the picture at Havnø somewhat changes this view.

With new research in the last several decades, the picture of the last Mesolithic and early Neolithic has expanded significantly in northern Germany, particularly in Schleswig-Holstein around the Mecklingburg Bay (see Hartz et al. 2007). This research has yielded a number of unfortunately mixed EBK-TRB assemblages, which nevertheless represent a major and useful dataset for understanding the nature of the earliest Neolithic in the region. Two assemblages are of particular note, Neustadt and Wangels, which both demonstrate notable difference with the available Mesolithic data from the region (Chapter 2). Despite being mixed, both show significant change from a purely Mesolithic faunal economy. Wangels shows meaningful inclusion of domestic animals in the material with the arrival of husbandry (Heinrich 1999). Neustadt, on the other hand, is quite different (Glykou 2011). Domestic animals are present in this assemblage, but at low numbers. The rest of the remains are seals and wild species.

In comparison with the east Swedish pattern, it is tempting to suppose a situation where the Neolithic material from Neustadt mirrors the seal-focused sites in east Sweden as a counterpoint to the Neolithic material from Wangels mirroring the domesticate-dominated sites in east Sweden. Unfortunately, it is pure conjecture at this point but the data do indicate, in conjunction with the EBK sample, that both transitional sites still represent a major difference between the Mesolithic and Neolithic data from the region. Importantly, data also indicate the possibility that at Neustadt, the arrival of the Neolithic also may have meant shifts in wild resource use in conjunction with the introduction of domestic species.

Discussion

The preceding considerations of various lines of evidence and comparisons has been made in order to discuss general trends in what is observed in faunal assemblages coming from the last Mesolithic and the earliest Neolithic. While not directly comparable due to substantial geographic separation across the entirety of southern Scandinavia, there are some generalized observations that can be made about the earliest Neolithic in the region. Based on the literature and on existing chronologically distinct data and occupation episodes at the sites presented here, it appears that in the earliest Neolithic there is a region-wide dichotomy separating those sites that have evidence for substantial introduction of domesticates and those that do not. Most often, these sites contain at least 50% domestic species, and in most cases nearly entirely domestic species. Their counterparts on the other hand, consist of nearly entirely wild species, with at most a handful of domestic forms. The character of this type of site varies by region, with east Swedish sites dominated by seals, Zealand coastal sites continuing the Mesolithic pattern of exploitation, inland Zealand sites shifting their utilization of wild resources, and coastal Jutland sites exhibiting a pattern similar to those in coastal Zealand. So, on a pan-regional scale, this appears to be some permutation of the settlement site-catching site dichotomy as described elsewhere (Johansen 2006).

For this reason, the sites at Wangels and Havnø are extremely interesting. This is because, despite their mixed assemblages, these two transitional locations have more domestic animals than at catching sites and therefore are either settlement sites, or a third kind of site that does not fit the dichotomous model. If they are settlement sites in the early Neolithic, then it is expected that most of the early Neolithic fauna will be domestic. In this case that would mean that a substantial shift in the economy is evident at the exact same locality. This scenario would most likely be more strongly associated with some degree of indigenous adoption. If in fact these two sites represent an unlikelier third option, a mix of substantial agricultural activity and wild game collecting at the same location in the early Neolithic, this again points away from substantial immigration and hints to indigenous adoption, or at least intermixing of groups. Unlike the coastal sites that largely display evidence of continuity of economies such as Sølager and Visborg, Havnø and Wangels show an actual transition in the form of substantial agricultural activity. Therefore, at Havnø, the Neolithic brings a substantial and immediate economic reorganization with the Neolithic, not a gradual change.

The last site is Muldbjerg I, which in contrast to the EBK model of exploitation discussed in the preceding chapter, demonstrates a novel shift in use of wild resources between the Mesolithic patterns of exploitation on Zealand (see above). Perhaps for the first time a cultural disruption may be spoken of that affected those Neolithic groups that had not yet started farming. Of course, the site could simply represent a rare example of such an adaptation on Zealand for hunting furs, but it also may demonstrate that other processes are occurring. Based on one site, the causes or mechanisms of change are unclear, but it can probably be accurately said that neolithization is not restricted to the inclusion of domestic animals at various paces into a pre-existing economy, but may also have consisted of a re-organizing component of the extant economy independent of the domestic species themselves.

Conclusions

Unfortunately, due to the general dearth of investigated sites, particularly those reporting of economic aspects of the earliest Neolithic in southern Scandinavia, most available faunal data are limited in scope (Hallgren 1998; Segerberg 1999), only briefly reported (Andersen 1989; Nielsen 1997) , from mixed contexts (Heinrich 1999; Havnø, Chapter 7), or incomplete. Nonetheless, there are some exceptions (Glykou 2011; Noe-Nygaard 1995). The earliest Neolithic in southern Scandinavia does appear to ascribe to the various models indicating a general dichotomy of site types. That is, in the ENI it does appear that there are sites that are clearly divisible into those that are predominantly domestic animals and those that are not. This is in agreement with what has been stated elsewhere (Hallgren 1998, for example). This division has by some scholars been used to argue for immigration, designating the coasts as refuges for hunter-gatherers where they continued a Mesolithic way of life for a time (Sørensen and Karg 2012). While data obtained in this dissertation dispute their (Sørensen and Karg 2012) particular interpretation, data do seem to reinforce a dichotomous view of site type. Such a situation is in evidence in eastern Sweden, possibly western Sweden, Zealand, and probably Jutland.

Data from Schleswig-Holstein, and now Havnø, are somewhat ambiguous but with discernible meaning. In the case of Neustadt, the site represents a largely contiguous use of wild resources while at nearby Wangels a major shift is evident given the numbers of domestic animals. The above situations underscore the importance of Havnø. Without being separated by time period, all domesticates at the site (except dogs) can be assumed, and some proven, to date to the ENI. In conjunction with the large number of non-attributable congeners at Havnø, the Neolithic occupation almost certainly represents an economy that is primarily comprised of domestic species. Therefore, the site represents the first example of such a locality in Denmark. In comparison with the model of variability presented for the EBK, and in particular the data from Zealand, the data from Muldbjerg I (Noe-Nygaard 1995) stand out as unique. In this case, the focus on fur animals at the site exceeds the abundance of any other similar resources during the Mesolithic on the island (despite a rather large sample) and may indicate a shift in use of wild resources between the Mesolithic and the Neolithic.

Chapter 11: Conclusions

Introduction

The ultimate goal of this project, while not to solve the question of agricultural origins in southern Scandinavia, was to address it from a regional and antecedent perspective in order to inform future studies in the region. This perspective was used in order to understand agricultural origins in this region, particularly the shell-heap at Havnø. A number of goals were met in order to do so. First, I zooarchaeologically and isotopically analyzed three EBK sites, all of potentially divergent economic use, in a restricted area of northwest Zealand and integrated them with a fourth which had already been excavated and analyzed by the same researcher. From this fourth site, Smakkerup Huse, I also integrated some new analyses of isotopic ratios in animal bone. Second, I likewise analyzed the transitional shell midden at Havnø. Third, I arrayed this new sample with published EBK data, relying only on larger assemblages instead of all assemblages in order to build a representative model of EBK resource use. Finally, I considered these new data in conjunction with the data from Havnø and other larger Neolithic assemblages from southern Scandinavia in order to assess the applicability of current models used to understand the earliest Neolithic in the region.

Analyses were initially tailored to answering a number of questions, which included: 1) What can the faunal remains and C-N isotopic ratios from these four sites tell us about human behavior and the local environment? 2) How variable are EBK faunal assemblages and what does this variability mean? 3) How well do the new and aggregate data fit accepted models of EBK and TRB resource use? 4)How much of a change in resource exploitation is apparent about the EBK-ENI TRB transition, and what explanatory implications does this have for the origins of agriculture in the region? The answers to these questions will be addressed in turn, along with specific findings germane to each question.

The Individual Sites and Data Obtained

The first step was to glean as much information as possible about human behavior and the local environment at each site addressed. For obvious reasons, comparative study cannot take place without at least a tangential understanding of the purposes of a site, and the human activities behind that which is found. By focusing on a region of high potential environmental variability during the Stone Age (Paludan-Müller 1978), the expectation was that the local environments and purposes of the sites would be largely different. This expectation was met, but as much of the data are not interesting alone, it is only meaningful in context with the other nearby sites. These data will be discussed further below.

Concerning human behavior, there are many other lines of evidence. Faunal data in particular, supplies several measures were of the upmost utility in differentiating these localities. On an individual site level , the most important information germane to comparative studies were the species found, how many species were found, the body size of particular taxa, what parts of the body were present, the seasonality of the sites, and the presence or lack of certain treatments of the remains. These were not the only data collected: other findings can be found in the individual site chapters.

Notwithstanding, the localities in northwest Zealand were very different from each other. Asnæs Havnemark is a roe deer hunting and cod fishing site at the end of a long, coastal peninsula. Sealing, fur animal trapping, and birding were secondary concerns. The site was visited not necessarily continuously over much of the year. Trustrup was an inland lakeshore settlement visited, perhaps seasonally, for the hunting of game including red deer, roe deer, and wild boar. Fårevejle, a shell midden located along the inland coast of the Lammefjord, was visited in a highly seasonal fashion for the hunting of wild boar and other game species. Some fox trapping occurred as well. These three sites represent not only contrasting site types, including a coastal hunting camp, a shell midden, and an inland lakeshore settlement, but also variable resource zones, from exposed to sheltered localities.

Variability in the EBK and its Meaning

For lack of frameworks of understanding, explaining differences in what is found at EBK archaeological sites is largely dependent on noticing that there are differences, pointing them out, and then reaching concluding generalizations about sedentism, identity, and territoriality (Petersen 1984). Previously, studies of variability in different forms of material culture, including types of axe, bone tool, and other artifacts have noticed that there are multi-scalar differences between regions (Petersen 1984). That is, certain differences are seen on a more local scale than others, such as the variation within different regions of Zealand in axe type, or the presence of T-shaped antler axes between the eastern and western EBK, separated by the Storebælt (Petersen 1984). Some reasons for these differences are speculative. Except for ethnographic analogy there are no other ways of definitively testing what these differences mean. Thus, the situation limits us to saying confidently that in different areas of the EBK, there are variable patterns of human activity. The scale, nature, and contexts of this variation are dependent on a number of factors. Similar statements can be made about the early TRB, where ceramic types can be relegated to different groups of individuals living in particular areas (Koch 1998).

Until recently, variation of what is actually showing up in faunal assemblages was largely not addressed in terms of whether or not there were identifiable differences between regions that are not strictly attributable to the local environment the availability of resources. Naturally, this is among the hardest traits to identify, but most observations were nevertheless predicated on the simple fact that one cannot hunt something that is simply not there. It has long been known that during the Atlantic period there are differences in this simple availability across the EBK culture-area (Aaris-Sørensen 1980; 2009). More recently, some regional comparisons have been undertaken. Unfortuntaely, these were largely conclusion-light, pointing out through exhaustive analyses that the availability of resources results in different things ending up in Stone Age deposits. These things were most often the resources found locally (Enghoff 2011).

The question then becomes how does one identify differences between areas or regions of the EBK that *are not* due to simple resource availability, and does this tell us anything new about the culture. The first step is to simply identify widespread differences present in the use of faunal resources. This is accomplished through amassing a dataset that considers regional, but also culture-wide viewpoints in order to establish on what scale differences or similarities are observed. The second step is to consider what might be causing said differences, with particular focus on those that could be due to other, external factors. The third step is to identify which differences are not attributable to non-cultural processes, using these to understand what may be real separations in human behavior between geographic areas.

In consideration of the above, new data presented here *indicate that faunal resource use in the EBK is highly regional, and this regionality is found at multiple, nested scales*. However, the situation is extremely complex. This means that difference may be observed more or less broadly depending on the particular trait in question. Some traits do not appear to be indicative of any regional variation at all. Further, variability is observed among some traits, but the scale of this variability at present is unclear. In general though, observed scales of difference are on the order of those first pointed out for flake axes by Petersen (1984), on a larger more regional scale, between broadly different regions of the EBK, and on an EBK-wide scale. A number of lines of evidence support this notion, including the butchery and transport of deer, numbers of species at the sites, the species that are present at sites, the relative abundance of species, the presence or absence of so-called "specialized" sites, the regionally-specific sizes of particular game species, and the focused working of dog bone.

Culture-Wide Trends

Some aspects of the EBK faunal economy, particularly numbers of species at EBK sites, are applicable across nearly all or all of the culture-area. Taking into account local extinctions, and the local availability of particular species (e.g. inland sites will not have as many sea mammals), Ertebølle sites, on average, have 14 species of useful mammal (Chapter 9). This represents, in most cases, nearly all species that are available in the local environment. Strong conclusions about the variability of bird usage in the same sample are likely masked by taphonomic processes. Fish species are also highly diverse in EBK assemblages.

There are also a number of species that never appear in large numbers, and despite their presence were not major resources for EBK groups. Rather unimportant, these include wolves, beaver, lynx, badger, polecat, and red squirrel. Of consistent and high abundance at nearly all EBK sites are red deer, roe deer, and wild boar. Finally, despite differences in the degree to which all species were obtained, it is clear that if a resource was present locally, EBK hunters had the capability to obtain it, indicating a very high level of skill and adaptability. These general statements are applicable culture-wide.

Broad-Scale Difference

Between broad areas of the EBK, the largest scales at which differences are observed are between the western and eastern parts of the culture-area separated by the Storebælt. Differences in fish usage have previously been reported by Ritchie (2010) who noted that on Zealand almost all fish assemblages were dominated by cod and flatfish , while west of the Storebælt, the resources and their relative abundances were much more varied. To this observation is added a similar pattern of terrestrial resource use. Simply, roe deer are more important on Zealand than elsewhere in the EBK and wild boar are less important on Zealand than elsewhere in the EBK. This fact may have much to do with island geography instead of other factors, but is observed nonetheless. The most interesting difference between the eastern and western EBK is the virtually complete absence of "specialized" sites east of the Storebælt. Of particular note concerning this is the fact that sites west of the Storebæt that are focused on particular species, are focused on species that are ubiquitously distributed across the culture-area.

"Specialization" or "specialized" are problematic terms which usually are used with no consideration of what they imply about faunal economies and human behavior. In particular, I do not think we can use the same term for human adaptations to the environment, many of which we cannot control, as we can for other human-choice based processes such as craft specialization or occupational specialization. Specialization in reference to faunal economies has had variable definitions. Some definitions describe specialized sites as those, "where the majority of faunal remains belong to a single species," (Zvelebil, 1995:84). In this case, the, dominance of a particular species appears to be used as the criteria for defining a "specialized" site. Other definitions include specialized sites as seasonal camps that, "are likely to be directed towards the exploitation of a particular resource, and may thus be in rather specialized locations" (Rowley-Conwy 1983: 122). Other authors define specialized sites as those that seem to be focused on a particular resource that would have required a high level of skill to obtain (Richter and Noe-Nygaard 2003).

Several EBK sites may fit some or all of these criteria. For example, Agernæs is a site on Fynen with a high proportion of animals taken for their furs, including young deer, pine marten, and other species (Richter and Noe-Nygaard 2003). The site is seasonal, visited during two restricted periods of the year with little evidence of visits at other times. Under Zvelebel's (1995) definition however, this site would not be "specialized" as the desired resource is of several species distributed in terms of taxa. Agernæs does meet Rowley-Conwy (1983) and Richter and Noe-Nygaard's (2003) criteria. It is clear that a high level of skill was required to acquire the furs, the site is highly seasonal, located advantageously for fur procurement, and clearly focused on a single resource.

Another possible example is Hjerk Nor, located along the Limfjord in northern Jutland. Although there are some doubts as to how representative the sample is, the assemblage is dominated by remains of the European wildcat, probably hunted for its fur (Hatting et al. 1973). Unfortunately, there is no seasonality evidence available for the site, but under the three separate criteria described above, the site is best described as a specialized wildcat hunting site. These two examples are of course not the only sites that may fit these criteria. Others may include Vængesø III, Aggersund, and Tybrind Vig (Andersen 1978, 2009; Enghoff 2011). However, the main thread of similarity that runs through these "specialized" sites is the use, procurement, or dominance of something "special", whether it is a particular, less common species, a particular resource such as fur, or a particular type of animal such as sea mammal.

Therefore, "specialized" sites are found in conjunction with more generalized sites of the EBK. However, none of this type of site are found on Zealand since there are no sites on the island that fit the criteria except those which have a very high representation of red deer, roe deer, or wild boar. Examples are Spangkonge and Åkonge, sites which show dominance of red deer, up to around 75% of the recovered materials (Gotfredsen 1998; 2003). The fact is that the corpus of EBK assemblages from Zealand nearly always are dominated by red deer, roe deer, and wild boar in varying proportions to one another and supplemented by other species. This implies that specialization on Zealand, according to the model and available data, probably has a divergent character than elsewhere in the EBK area, and ultimately depends on, for its definition, a degree of gradation to identify (Enghoff 2011; Gotfredsen 1998; 2003; 2004a; Magnussen 2007; Møhl 1971; Price and Gebauer 2005; Skaarup 1973). It is reasonable to assert a complete lack of truly specialized sites on Zealand of the type found elsewhere in the EBK. There is a broad-scale difference between the western and eastern EBK in this regard.

Regional Differences on a Smaller Scale

Some differences on the order of those observed for differences in flake-axe type observed by Petersen (1984) are visible on a more regional scale of areas approximately 50km across. This size of region is similar to that used by Enghoff (2011). In terms of faunal resources exhibiting patterns, Ritchie (2010) presented data indicating that in northwestern Zealand, assemblages were almost always dominated by cod, while in northeastern Zealand, both cod and flatfish could dominate. Together, both regions were different from the western EBK, in which fish assemblages were much more variable. All assemblages from all regions are highly rich in species. This is not to say that these differences are predicated on human choice although availability played at least some role. The point is, among the fish remains there were consistent regional geographic differences.

Considering the new data from Northwest Zealand, it also appears that there are differences in the relative abundance of resources between coastal northwest Zealand and the nearby inland Åmose system. Åmose sites are almost all dominated by large game, particularly red deer, while in northwest Zealand, the big three are more variable in their representation. This difference is probably not cultural, but almost certainly predicated upon availability of resources, proper habitats, and possibly dissimilar animal populations between the regions. Reinforcing this is the notion that the size of prey animals varies on the island of Zealand. Coastal populations consist of markedly larger animals than those from the Åmose. Based on their dataset from the Åmose, Richter and Noe-Nygaard (2003) previously argued that animals from Zealand were usually smaller than those from mainland Denmark and elsewhere. This study suggests that this is not exactly the case. The northwest Zealand game animals are more similar in size to those from Fyn and Germany, at the time attached to Jutland, than to those from the Åmose, which perhaps indicates different populations, environments, or hunting pressure in the two regions. Therefore, terrestrial game populations had the potential to be markedly dissimilar, regardless of cause, on the regional scale during the EBK. This may have had an effect on hunting practice.

Local Differences

From this research it is clear that some activities of EBK hunters are of a very local nature, perhaps only practiced by a single group, or even a single individual. Such idiosyncrasies are often not visible in the archaeological record from the Stone Age, but at Asnæs Havnemark, one appeared Fishhooks are rarely encountered at EBK sites, and even more rarely are preforms, or worked raw material. At Asnæs Havnemark however, excavations revealed all three. Of particular note was the worked dog long bones, coming from the sole species which showed any evidence of working. This has not been encountered before at an EBK site. This may actually represent a local adaptation, or tradition, or otherwise, but may also be more widespread, although lacking in data. At Asnæs Havnemark, fishhooks were manufactured from dog bone exclusively. Surely there was some reason to do so given the availability of other suitable raw materials. Testing hypotheses concerning the reasons for this however, particularly in reference to mechanical properties of dog bone would be profoundly difficult, as it would require obtaining a number of dog carcasses.

Differences of Unclear Extent

One of the most interesting findings relating to variability in EBK resource use is the lack of transport of deer at EBK sites on Zealand versus clear evidence of transport at Ringkloster (Rowley-Conwy 1994-1995). Studies of this type have largely suffered from lack of locally or regionally comparative samples. That is, all previous studies of skeletal-part transport, or studies that included assessments of skeletal-part transport from EBK contexts, assessed these data alone, and without local or regional comparisons (Ericksson & Magnell, 2001; Gotfredsen 2003; Jonsson, 1988; Trolle-Lassen, 1990;

Rowley-Conwy, 1994-1995). Therefore, the picture has been rather disjointed, one-sided, and incomplete. With the analysis of body-part profiles from Asnæs Havnemark, Fårevejle, and Trustrup, and with the conclusions drawn about the lack of selective body-part transport (Chapter 9) at these three sites, for the first time a multi-site picture is presented. The results were unexpected. At these three sites there is no selective transport of deer, which is in direct opposition to what one would expect in a logistic resource procurement system typical of collector hunter-gathering (Binford 1980). This is in contrast to what is observed at Ringkloster (Rowley-Conwy 1994-1995), and may be similar to what was observed at Skateholm, Spangekonge, Bökeberg, and Tybrind Vig, at which, while sometimes quantified differently, apparently all parts of large game were found (Jonsson 1998, Gotfredsen 2003, Ericksson and Magnell 2001; Trolle-Lassen 1990). To be taken from this finding is that logistic extraction practice is consistent on a regional level, and variable culture-wide. This is an important finding as it illustrates that even general models are not applicable to all resources at all times, as in the case of northwest Zealand, not all resources are part of collector extraction, and may have simply been so abundant or unimportant that they were procured locally.

Northwest Zealand Conclusions

Broad trends aside, some conclusions are appropriate concerning resource use in northwest Zealand. When taken in conjunction with the already published and new data from Smakkerup Huse, these results may also serve as a case study in regional resource exploitation in the EBK on Zealand. The general picture is one of consistent and mostly stable use, treatment, and habitat types for procurement of the same resources at multiple locations in the region, regardless of location of sites. This picture is supported by stable isotopic data, body-part representation data, and relative abundance data concerning both terrestrial and marine components of the diet.

Concerning the stable isotopes, broad consistency is observed between stable isotopic values, and therefore between habitats supplying the big three. This is interesting because presumably, given the variation in site type and location, there should be some places that are better than others for the procurement terrestrial prey. This consistency in the isotopic findings indicates that despite the fact that deer and boar are flexible species capable of inhabiting numerous, widespread habitats (Geist 1998; Melis et al. 2006), appropriate habitats for terrestrial species in northwest Zealand were all similar. Therefore, EBK hunters were not moving to areas where the big three were available from areas from which they were not available in order to hunt, but were instead hunting them where and when encountered. This means that relative abundance values as observed in assemblages of these game types reflect local abundance. Furthermore, specific parts of deer were not being transported between sites in northwest Zealand and were probably not part of a logistic extraction system. This is a repeated finding at the sites where assessments were made. As isotopic data from humans and dogs from these sites (this study; Price and Gebauer 2005) indicates nearly a completely marine protein component, taken together, these lines of evidence may indicate that hunting of the big-three in the region may have simply been an *ad libitum* and supplemental, albeit consistent, part of the EBK food economy, and that the abundance, hunting environments, and treatment after death were unvarying.

Unvarying use of available resources is also seen in terms of the representation of terrestrial and marine resources in the region. The terrestrial component of all assemblages is dominated by the big three, with the lesser use of other resources. Red deer, roe deer, and wild boar always dominate the terrestrial component, while along the coast, codfish and flatfish dominate the fish assemblages. There is little deviation from this pattern in northwest Zealand and in the cases where differences are apparent, they are always predicated on availability at a given location (e.g. fish are far less common at inland sites and no seals can be hunted along freshwater lakes). Also in these cases, differences predicated upon other species are minor with respect to the overall assemblages.

Accordingly, when looking to describe a particular regional hunting, gathering, and fishing tradition in northwest Zealand, one must speak of a broad, but highly consistent resource base predicated upon a few key resources. EBK hunters focused on codfish, flatfish, and the big three, and not much else was very important to them. Many other resources were procured, but these were never a large part of the economy despite the completely adequate and able EBK hunting strategies for all species present in the environment. Yet these resources were hunted anyway, albeit at low levels.

This consistency is interesting in regard to the *inconsistency* elsewhere in the EBK area. The aforementioned high variability in resource use across the EBK culture area occurs at a larger scale than that of this regional study of northwest Zealand. Specialized sites, while present elsewhere, do not seem to exist on Zealand. Therefore, this sample illustrates that within regions, hunting was probably highly similar while without regions, variability was high. This seems to be somewhat independent of environmental variability, as Zealand may have had some of the most diverse local environments during the Atlantic period (Paludan-Müller 1978). In sum, this indicates that hunting traditions, practices, and undertakings were at least partially culturally defined during the EBK, and that it may be time to speak of regional differences in hunting practices in the same way as regional differences in other forms of material culture.

Agricultural Origins Conclusions

The analysis of the faunal material from Havnø, the transitional shell midden from eastern Jutland represents a major contribution to our understandings of the early Neolithic in southern Scandinavia. The assemblage presents two perspectives on the introduction of the Neolithic: a local, focused view of the extent of change at the cusp of farming, and a window into the applicability of broader models of transitions in the region. On a local level at a transitional midden for the first time, Havnø demonstrates real and significant agricultural activity in the earliest Neolithic. On a broader scale, the site complicates our views of how the earliest Neolithic food economies are understood.

At the midden, regardless of my ability at this time to separate the Mesolithic and Neolithic components of the assemblage, it is clear that in the earliest Neolithic there is a major domesticated animal component at the site, and therefore substantial agricultural activity. Given the local data from Visborg, as well as the fact that at least some of the Havnø material is undoubtedly Mesolithic, this indicates a substantial shift from a hunter-gatherer-fisher lifeway to that of a farmer in the early Neolithic at the exact same locality. First, domesticates make up at least 10% of the assemblage and probably more, a proportion larger than at any other transitional site from Denmark. This is particularly underscored by the fact that this proportion is based on an assemblage that contains Mesolithic materials. Second, isotopic evidence in comparison with wild boar from Zealand indicate that at least some of the swine at the site are almost certainly domestic as well. Third, cattle at the site are browsing in the same environments as deer, probably indicating that they are being raised on, or near to the site. Finally, the site was located on an island during the Stone Age, and therefore would have been suitable for husbandry, particularly given the extensive coastal grasslands that are indicated nearby to the site, even today, and the natural barrier water would provide against predators and escape.

These data, taken in conjunction with previously published data from southern Scandinavia has some important implications for models of agricultural origins and agricultural practice in the early Neolithic. Many scholars suppose that in the earliest Neolithic a dichotomy of site types exist; those that exhibit a significant degree of continuity in terms of animal economy with the Mesolithic and those that are largely Neolithic in terms of being predominantly based upon domestic species (Johansen 2006; Sørensen and Karg 2012). This dichotomy seems largely supported (Chapter 10). However, what this view has largely concluded, at least in Denmark, is that at transitional sites, a Mesolithic way of life continues for a time, while elsewhere, predominantly Neolithic husbandry is occurring. There are numerous examples of transitional middens with a predominantly wild-based economy in the ENI (Andersen 1991; Bratlund 1993; Enghoff 2011; Skaarup 1973), examples of wild-based non-transitional sites from the Neolithic (Noe-Nygaard 1995; Segerberg 1999), and sites from the ENI that are clearly focused on nearly exclusively domestic species (Hallgren 1998; Koch 1998). This dichotomy as described implicitly supports the notion of a period of transition and a dualistic economy in which the same people are doing very different things at two different types of site. What it does not support directly however, is a convincing indigenous adoption of agricultural activities, as the transitional sites showing locational fidelity also show a largely similar wild-based activity pattern in the ENI. In fact, this has been argued to indicate that agriculture arrives in the interior first, and the coasts remaining “refuges” of sorts for Mesolithic folks in the early Neolithic (Sørensen and Karg 2012).

Following the above discussion, Havnø is the first site from Denmark where a real change is apparent at the same site between a wild-based faunal economy and a more Neolithic, domestic animal based economy. The transition can therefore be directly observed at a single site where locational fidelity is observed. Of course, this may simply be owed to the fact that Havnø is a rather unique location, and was ideal for both hunting-gathering-fishing and animal husbandry during the Stone Age, but it also may be indicative of something more. This something, of course, may be indigenous adoption of agricultural products into the food economies of formerly Mesolithic people. As the site is occupied in the Mesolithic and Neolithic at the same locality, this argues against a complete replacement by immigrants, of EBK groups at the midden.

One of the major questions of this project concerned how much change in faunal resource use was evident at Havnø between the Mesolithic and Neolithic layers, and using these data to address food crisis models of agricultural origins. Unfortunately, stratigraphic issues at present prevent an assessment of this question, save for the preceding discussions of the inclusion of domesticated animals in the material. As it is clear that there are many wild animals as well however, given this lack of separation, this question is not directly addressable until further work and research is done. *Therefore, the question of the shift in wild animal use at Havnø in the context of changing environments must remain unanswered at present.*

Nevertheless, Havnø may represent a new type of site in dichotomous models of early Neolithic husbandry, the transitional, coastal site indicating the substantial rearing of livestock and other domesticated animals. I will not over-interpret this statement, except to say that given the regional types of other material culture such as ceramics in the ENI (Koch 1998), it is not impossible that regional differences in Neolithic faunal economies, on the geographic order of those in the EBK, may have existed. In fact, I suspect that regional differences probably are in evidence.

Final Thoughts

This dissertation has built a model of EBK variability in a restricted region of the culture, northwest Zealand. In many respects this variability pertaining to many aspects of how EBK groups obtained, used, and discarded resources is low on this scale, while it is demonstrated to be much higher on a broader level. Not only are EBK groups distinguished on a regional level by differences in material culture, but also by differences in how they used faunal resources. Concerning the Neolithic transition, significant agricultural activities are recorded at a transitional site in the earliest Neolithic, indicating a significant change in faunal economies with the earliest Neolithic. This at least, in part, argues for a degree of indigenous adoption.

Big questions addressed in the course of this research included; 1) what can the faunal remains and C-N isotopic ratios from these four sites tell us about human behavior at the sites in question and about the local environment? 2) How variable are EBK faunal assemblages at the regional and culture-wide level and what does this variability mean? 3) How well do the new and aggregate data fit accepted models of EBK resource use? 4)How much of a change in resource exploitation is apparent about the EBK-ENI TRB transition, particularly at Havnø and what explanatory implications does this have for the origins of agriculture in the region?

I have answered more questions than these in the course of this research, largely given the large dataset which contained many surprising traits. Aside from the descriptive aspect of the first question, in short, the answers to the other questions are: 2)There is not much variability on a regional level, but a lot on an inter-regional level, 3) The new data adheres to our general impressions of EBK resource use but has a local, regional character of its own, and 4) Culture-wide, the degree of economic shift is variable with the introduction of the TRB, but a lot of change is evident at Havnø, and this change partially argues against a continuation of a Mesolithic way of life at the site. Havnø does not fit neatly into current dichotomous models of TRB faunal economies, particularly at transitional sites, and may be indicative of a region-specific character of early farming in southern Scandinavia.

Nevertheless, based on my research, several broad conclusions can be made about Ertebølle resource use and the transition to agriculture in South Scandinavia. First, environmental change, even if evident, could not have compelled Ertebølle groups to adopt agriculture because of significant flexibility of Ertebølle groups in their ability to switch among all available resources and therefore weather all but a complete environmental catastrophe. Second, evidence presented here does not indicate a gradual agricultural adoption at all sites, but in fact a more abrupt transition, with animal husbandry in strong evidence even at transitional shell middens. In all, I argue for strong culturally-defined regionality in faunal resource use in part independent of environmental variability, particularly in the EBK, and for the possibility of similar regionality in the earliest Neolithic as well.

A Word about Plant Foods, Cereals, and Cultivation

The Neolithic is not defined only by domestic animal husbandry, but also, and perhaps more importantly, by domestic plant cultivation. This dissertation has predominantly focused on the animal component of the EBK and TRB economies, assigning agricultural transitions to a secondary role. This surely is not representative of the actual importance of plant resources in the Neolithic and in the Mesolithic. The problem is that the two datasets are largely incongruent, and data of the type that are available cannot be used to address the same proximate questions. Further, flora data are also not as extensive. In some cases bone is well-preserved while the remains of flora are long decomposed. This is the case at Skateholm, for example (Göransson 1988). Thus, discussions in a quantitative sense concerning both datasets have remained frustratingly obtuse, given that they are inherently sample biased. In order to at least address the role of plants in the lives of the inhabitants of southern Scandinavia both before and after the arrival of agriculture, I will first discuss some of the evidence for plant foods in the EBK. Second, I will address the types of evidence available for the understanding of cultivation of domestic plants and animals in the ENI. Third, I will discuss the question of degree when reporting the first agriculture in the region, and then finally I will conclude with some remarks about the plant and animal data together.

EBK resource use surely had some plant-based component, both in a subsistence sense, but also as an important source of raw materials for the manufacture of various useful items. Data indicate for example that at least four classes of plant foods, including root vegetables, nuts and grains, berries and fruits, and other vegetables may have been consumed at Tybrind Vig (Kubiak-Martens 1999). More specifically, hazelnuts were surely an important part of the EBK diet at Smakkerup Huse, while acorns, chestnuts, fruits, and a variety of other plant foods may also have been consumed (Price and Gebauer 2005). In Sweden, other authors describe varying use of the landscape, including collecting of specific plants, including possibly ferns for consumption (Göransson 1988). Similar data at Bökeberg III indicate the probable consumption of several species, including acorns and hazelnuts, and the non-consumption use of certain species for fuel and thatching (Regnell et al. 1995). Clearing or exploitation of woodlands for fuel and raw materials has been supposed from changes in pollen abundances at Ringkloster as well (Rasmussen 1994-1995). In all, variable EBK plant foods obtained through foraging surely were an important part of the diet, possibly rivaling as dietary components resources which are more commonly preserved in various contexts.

As with the EBK sample, lines of evidence concerning the start of the cultivation of domestic plants at the beginning of the TRB are limited by the comparatively fragile nature of plants. Evidence is disparate, and includes plow-marks, cereal impressions in ceramics, charred cereal grains, an increase of domestic species in pollen samples, and evidence of food processing and threshing (Sørensen and Karg 2012). The problem is that cereal impressions or the grains themselves do not necessarily mean that they are being grown locally, and certain types of plant foods are easier or harder to identify with certainty. In addition, pollen samples are beset by problems including the fact that the reproductive biology of cereals dictates that pollen only spreads very limited distances, and that lake cores may reflect only very local conditions (Sørensen and Karg 2012). In other words, until widespread agricultural activity is occurring, it is extremely hard to identify its presence, let alone its intensity, utilizing palynological methods. However, available data does indicate the arrival of emmer, einkorn, barley, and bread wheat by the ENI.

In all, the number of ENI imprints or actual charred cereals from Scandinavia number in the thousands (Sørensen and Karg 2012). When the available dated samples of grains are considered (Sørensen and Karg 2012), a few fall prior to 3950 cal. B.C. This is not enough to claim any convincing agricultural activity prior to that date. In sum, the introduction of domestic plants occurs between ca. 4000 and 3700 cal. B.C.

Despite general agreement as to when domesticated plants and animals arrive, the question of how this process proceeds remains somewhat murky. This is because apparently the transition from foraging to farming happens, at least partially as a somewhat gradual move from a situation where none of the people and no part of the landscape is agricultural, to a situation where all of the people and all parts of the landscape are agricultural. There remains a major disagreement about the *degree* to which plant cultivation contributed to the food economy in the earliest Neolithic. During this period, domesticated plant foods cannot be convincingly shown to have been a significant contributor to the diet (Jensen 1996; Price and Noe-Nygaard 2009). In this way, the available data concerning the plant-based economy of the ENI is similar to the available data concerning the animal-based economy of the ENI. Yes, domesticates are present at or around 3950 cal. B.C., but how important they were remains unresolved fully until the start of the Middle Neolithic (MN) around 3500 cal. B.C. By this point, there is no doubt that the residents of southern Scandinavia were “fully” Neolithic (Price and Noe-Nygaard 2009).

When taken together, the datasets concerning the economic use of plants and animals both in the EBK and TRB are complementary, albeit problematic, to directly compare. In the EBK, both the plant data and the faunal data can tell us many of the same things such as; information about the local environment, and which species were utilized and how. However, pollen data can inform only about the local environment, and not about which species were actually utilized. Further, plant remains are most often simply not preserved. It is concerning the arrival of agriculture where the real problems come into play, however. The lines of evidence available for understanding plant use in the ENI are limited to indirect indicators (plow marks, impressions, evidence of food processing or harvesting), direct, but rare indicators (charred cereal grains), and palynological evidence. While each dataset has its advantages and disadvantages, the common thread found in all is that the real issue is of degree: How does one relate these data to the actual importance of domesticated plant resources in the lives of those TRB groups present in southern Scandinavia in the ENI? While the new data presented in this work at least partially addresses this question using faunal resources, but it remains open as to how to relate the faunal and floral data, and then how to together relate the pair to actual life in the ENI.

Recommendations for Future Research

This project raises many more questions than it answers. These range from more proximate to ultimate questions applicable to the sites investigated here to those more broadly applicable to agricultural origins in the region, and elsewhere. Foremost is the question of separating out the Mesolithic and Neolithic components at Havnø to discern exactly how much of the Neolithic material is wild, and what its composition was. This is also of interest given the unclear nature of the Mesolithic materials at the site. With more dates, ongoing careful stratigraphic excavation, and further consideration of available data, this question will be answered. The extremely complex stratigraphy within the midden and ever-evolving picture of the site precludes this separation at this time. Notwithstanding, this research will occur in the future. Of further interest is the distribution of bone material within the shell layers at the site, particularly in terms of how parts were distributed across the site. Such analyses were not performed here given their limited meaning without stratigraphic and chronological contexts. As these contexts become clearer, the distribution of bones within the heap will be clarified. This will have important and informative taphonomic implications.

The sites in northwest Zealand yield an impressive dataset with which to understand the regionality and variability of EBK hunting practice. These assemblages will shortly be joined by another collection from the settlement at Dragsholm, an EBK site very near to Fårevejle. These data still in preparation and not included here, when integrated with the data presented in this work, will further elucidate the picture of EBK faunal economies in northwest Zealand. In fact, with Dragsholm included, the northwest Zealand dataset will be among the most comprehensive EBK faunal economy collection from the culture.

On a broader scale, this research immediately raises questions about the nature of the earliest animal husbandry in southern Scandinavia. In particular, the question of seasonal practice and possible transhumance is raised. At present, such aspects of animal-rearing from the ENI are completely unknown. Needed are oxygen isotopic studies involving sequential sampling of early domesticate teeth from ENI sites in Scandinavia in order to determine the probable seasonality and its nature of husbandry. This is a study I intend to undertake, and have obtained permission in order to perform.

Finally, while the EBK dataset is very comprehensive, the ENI sample, particularly on a regional level, remains very incomplete. There are grave geographic incongruences between where the majority of EBK research has been undertaken and where some of the best ENI TRB research has been undertaken. Therefore, they are not often directly comparable. What is required is devoted ENI TRB research focused on an area where the faunal economy of the EBK is well-understood. Only then, given the probable regionality of both EBK and TRB resource use, will a true picture of the change from the Mesolithic to Neolithic be possible.

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Appendix I: Coding Rubric (modified from Redding et al. 1978) for Identified Specimens

Site (choose one)
Asnæs Havnemark
Havnø
Fårevejle
Trustrup
Specimen Number (assign one per specimen)
To be assigned
Identification (choose one)
Assigned to species as possible, except seals *Phoca/Halichoerus*, *Sus* sp., *Bos* sp., *Ovis/Capra*, and certain genera of birds and amphibians
Element
Element assigned as accurately as possible, sometimes combined (e.g. ilium-ischium)
Bilateral Symmetry (choose one)
indeterminate
right
left
medial
Fusion (choose one)
indeterminate
fused
fusing
unfused
proximal fused distal fused
proximal fused distal fusing
proximal fused distal unfused
proximal fusing distal fused
proximal fusing distal fusing
proximal fusing distal unfused
proximal unfused distal fused
proximal unfused distal fusing
proximal unfused distal unfused
undeveloped epiphyses
Fragmentation (how much of original bone is present, choose one)
indeterminate
complete
3/4 to complete
1/2 to ¾ present
1/4 to ½ present
less than ¼ present
Origin of Fragmentation (choose one)
indeterminate
predepositional
recent
Fragmentation is recorded differently for various bone elements. These values list what part of the bone is present
Fragmentation 1 (limbs, degree present)
indeterminate
complete

proximal end
proximal shaft
proximal end and shaft
shaft
distal end and shaft
distal shaft
distal end

Fragmentation 1 (mandibles, degree present)

indetermnate
complete
articulation
ramus
articulation and ramus
cheek and articulation
diastema and cheek
symphasis to cheek
diastema to articulation
symphasis and diastema
symphasis
diastema
cheek

Fragmentation 1 (maxilla and skulls, degree present)

indeterminate
complete
proximal
central
distal

Fragmentation 2 (limbs and vertebra)

Indeterminate
complete
anterior
posterior
central

Fragmentation 2 (teeth)

indeterminate
complete
mesial
distal
central

Fragmentation 3 (limbs, mandibles, maxilla, skulls)

indeterminate
complete
lateral
medial
central

Fragmentation 3 (teeth)

indeterminate
complete
labial
lingual

central
Fragmentation 3 (vertebral)
indeterminate
complete
right ½
left ½
central
Fragmentation 4 (mandibles)
indeterminate
complete
dorsal
ventral
central
Fragmentation 4 (teeth)
indeterminate
complete
crown
root
central
Fragmentation 5 (vertebra)
indeterminate
complete
arch
centrum
Tooth Rooting (choose one)
indeterminate
open
separating and open
separate but unclosed
closed
Relative Age (choose one)
Indeterminate
adult
juvenile
neonatal
Burning (choose one)
indeterminate
white
carbonized
burnt
partially affected
slightly affected
possibly affected
not affected
Disease (choose one)
indeterminate
diseased
possibly diseased
Modification (if more than one is indicated, these are listed together)
indeterminate

tool
worked
rodent gnawed
carnivore gnawed
gnawed
possibly worked
hunting marks

Butchering Marks (choose one)

indeterminate
butchering marks present
butchering marks possibly present

Type of Marks (if more than one is indicated, these are listed together)

indeterminate
cut marks
scrape marks
blow marks
sawing marks
chop marks
blow marks
skinning marks
dismembering
food processing
fileting marks
marrow fracturing
trampling
gnawed by dogs

Comments (entered freely)

Associated specimens

Indicate with which bones the specimen is associated

Appendix II : Comparative Measurements

All measurements follow von den Driesch (1976), Smakkerup Huse data from Price and Gebauer (2005)

Capreolus capreolus

Astragalus

Specimen	**Side**	**GLl**	**GLm**	**Dl**	**Bd**	**Dm**
AH24-12	L	31.4	30.5	17.7		
AH100-7	L	29.2	28.6		18.6	
AH1-29	L	28.2	27.5	16.2	18.3	
AH78-9	R	28.3	27.8	15.9	17.9	
AH25-19	R	28.1	27.4	16.4	18.1	
AH92-72	R	30		16.9	18.5	
AH52-24	R		27.6		19.3	
AH132-54	R	31.7	30.2	18.2		
AH74-1	R	29	28.5	16.4	19.1	
AH1-21	R	30	28.7	16.7	18.7	
F66-10	R	28	27	16.2	18.4	
F445-3	L				18.3	
F297-1	L	26.4	25.3	15.4	17.7	
F25-9	R	29.6	28.9	16.1	18.5	
F650-2	R	28.4	27.9	16.1	18.7	
T58-4	L	28.1				
T6-10	L		28.5			
T59-4	R				19	
T3-8	R				17.8	
T24-5	L		27.3			
SM412.500.5(10-20)-2	L	30	29.5		19	
SM412.502.5(0-10)-10	L	27	26	16	17.5	16.5

SM413.499.5-2	L	28.5	27.5	16.5	18.5	16.5
SM415.500.5-9	L	30	27.5		19	17
SM414.495.5-6	L	28.5	28.5	15.5	17.5	17
SM414.498.5-10	L	31	29.5	17.5	19	18
SM415.498.5G-12	L	28.5	26.5	16	18	16
SM415.499.5G-3	L	28.5	27	16	19	16
SM411.500.17(10-20)-25	R	29.5	28.5	16	18.5	17
SM412.501.27-6	R	31.5	30	18	19	18
SM414.501.5(10-20)-9	R	29	28.5	15.5	18	
SM414.502.27-1	R	31	30		19.5	18

Capreolus capreolus

atlas

Specimen	**GL**	**GLF**
AH136-14	45.5	42.7
AH62-32	46.8	42

Capreolus capreolus

axis

Specimen	**BFcr**	**SBV**	**LCDe**
AH132-25	38		
F143-11	36.6		
SM414.500.5(10-20)-6	37	20	58
SM414.502.5(0-10)-5	33		
SM415.497.5-16	34		

Capreolus capreolus

calcaneus

Specimen	**Side**	**GL**	**GB**

AH98-15	R	64.5	
AH25-20	R	57.4	21.2
AH132-51	R	62.9	21.4
AH25-50/AH25-72	R	60.2	18.6
AH133-35	R	58.4	
AH102-3	R	58.1	
AH24-49	R		22.8
AH4-15	R		21.4
AH70-11	R		20.4
AH140-19	R	61.1	20.5
AH98-9	R	62.3	21.8
AH140-15	L	63	21.6
AH47-2	L	63.9	
AH133-1	L	59.3	21.6
AH32-5	L	58.3	20.6
AH132-1	L	59.3	20.6
AH100-6	L	59.9	21.5
AH102-7	L	70.1	23.2
AH61-12	L	59.6	20.7
AH25-24	L	60.3	20.8
AH102-2	L	64.9	22.1
AH98-130	L		21.3
F172-14	R		20.7
F310-1	L	59.4	19.3
F412-1	R	59	
F616-1	R	59.9	18.8
F704-1	R	61.6	21.6
SM414.500.5(10-20)-1	L		20
SM412.501.5(40-50)-6	L	64.5	

SM412.502.5(40-50)-3	L	62	
SM413.500.5(30-40)-15	R	62.5	22
SM413.501.5(20-30)-6	R	62	21
SM412.502.5(0-10)-2	R	67	22
SM411.500.17(10-20)-2	R	63	
SM414.496.5-10	R	67	23
SM413.502.5(20-30)-1	R	62	

Capreolus capreolus
cervical vertebra

Specimen	**PL**	**Bpacr**	**Bpacd**
F367-1		12.6	
F63-2	33.7	13.7	25.9

Capreolus capreolus
cranium

Specimen	**Side**	**21**
AH151-22	R	30.3

Capreolus capreolus
femur

Specimen	**Side**	**Bp**	**DC**	**BD**
AH12-31	L	43.2	19.5	
AH77-22	R	40	18.6	
AH7-7	R	45.8	20.7	
AH72-3	R			39.5
AH25-1	R			37.7
SM416.497.5-1	R			36

Capreolus capreolus

humerus

Specimen	**Side**	**Bd**	**BT**	**Bp**	**Sd**
AH62-53	L	28.2	24.3		
AH36-54	L	28.1	24		
AH70-25	L		21.7		
AH132-2	L		25.7		
AH84-58	L	30.1	25.3		13.2
AH1-23	L		22.9		
AH36-4	L		25.1		
AH83-3	L	25.3	22.8		
AH98-6/AH98-57	L	29.9	25.5		
AH62-41/AH62-24	R			33.4	
AH2-13	R	28.8	23.7		
AH131-10	R		24.4		
AH73-15	R	29.4	26.8		
AH136-11	R	28.8	23.1		
AH7-3	R	34.4	25		
AH136-12	R	28.4	24		
AH109-20	R	28.4			
AH65-4	R	29			
F24-13	R	26.1	25.7		
F402-1	L	29.1	26.8		
T3-37	L				14.2
SM411.500.17(10-20)-5	L	29	24		
SM412.502.5(40-50)-4	L	28.5	23		
SM415.496.5-1	L	29	23.5		
SM415.501.27(0-10)-2	L	27.5	23		
SM415.499.5-4	L	27.5	22.5		

SM414.498.5-9	L	29.5	24
SM413.499.5G-1	L	25.5	22
SM413.502.5(10-20)-2	L	29	24.5
SM413.502.5(40-50)-1	L	28	23
SM412.500.5(40-50)-7	R	27	23
SM413.500.5(40-50)-2	R	25	22.5
SM413.501.5(20-30)-2	R	28	23
SM413.501.5(30-40)-1	R	27	22.5
SM414.499.5-2	R	29.5	25
SM413.499.5-4	R		23
SM415.498.5G-10	R	27	22.5

Capreolus capreolus
innominate

Specimen	Side	LA	SB	SH	LAR
AH7-4/AH7-19/AH7-17	R	29.4			
AH25-10	R	28.3	18.2		
AH72-2	R	27.1			
AH88-15	R	28.4			
AH25-28	L	29			
F333-2	L		18.9	18.3	
SM414.495.5-2	L		7?????		26
SM414.500.27(0-10)-2	L				26
SM414.500.27(0-10)-2,-6	L				24.5
SM413.502.5(40-50)-2	L				26
x68	R				27

Capreolus capreolus
mandible

Specimen	Side	8	9	12	15a	15b	15c	21b
AH32-67	R							14.5
AH52-11	R		26			16.4	14.1	
AH28-2	R		26.3			15.7	13.6	
AH4-18	R		27.7				15.7	
AH70-1	R		27.1				15.8	
AH25-13	R	36						
AH33-5	R	38.6						
AH57-2	R		27					
AH60-7	L							13.6
AH98-7	L				25.3			14.5
AH89-27	L		27.7			17.3	15.5	
AH62-43	L		26.2			16.9	15.9	
SM413.499.5-9	L						15	
SM414.498.5-5	L						13.5	
SM413.500.5(50-60)-1	L			52				
SM415.499.5G-2	R						15.5	
SM414.500.5(20-30)-2	R						13	

Capreolus capreolus
metacarpal

Specimen	Side	Bd	Bp	SD
AH77-21	L		22.1	
AH84-73	I	21.8		
AH36-23	I	20.1		
AH77-5	R	19.9		
AH132-32	R		19.3	
AH83-17	I	20.5		
AH131-50	I	21		

F177-17	R		20.4	
F218-32	R		21.2	
F684-8	R		20.3	
SM413.501.5(30-40)-6	L		20.5	
SM415.502.27(0-10)-15	R			13.5
SM414.497.5-13	R	21		
SM413.496.5G-2	R		19.5	
SM415.499.5-5	R		20.5	

Capreolus capreolus
metatarsal

Specimen	**Side**	**Bd**	**Bp**
AH98-72/AH98-39	I	22.8	
AH140-31	I	23.3	
AH77-3	L	22.9	
AH77-6/AH77-19	L	24.2	
AH136-20/AH107-3	R		19
AH93-3/AH93-12	R		18.3
SM414.498.5-11	R	20.5	
SM412.501.26(20-30)-1	R	23	
SM412.500.17(+8--2)-5	R	24	
SM413.502.5(40-50)-7	R		18.5

Capreolus capreolus
naviculocuboid

Specimen	**Side**	**GB**
AH89-6	L	24.2
AH98-26	L	24.8
AH28-15	L	24.1

AH92-25	L	21.5
AH27-5	R	23
AH1-39	R	24.5
AH27-3	R	21.8
AH136-5	R	22.9
F1-57	R	22.6

Capreolus capreolus

radius

Specimen	**Side**	**BD**	**BP**	**BFp**
AH62-54	L	26.5		
AH4-3	L		24.9	
AH89-38	L		25.9	
AH61-44	L		26.2	
AH43-35	L		27.6	
AH140-1	L		25.7	
AH132-3	L		27.5	
AH136-19/AH136-53	R		26.5	
AH83-2	R	22.7		
AH84-74	R	25.3		
AH84-25	R	27		
AH70-29	R		27.6	
AH136-27	R		26.1	
AH52-45	R	25.3		
AH4-35	R	24.2		
AH24-5	R		25.4	
AH77-30	R		26.2	
AH25-3	R	24.8		
F404-1	L		26.5	

F368-1	L		24.3	
F172-8	R		24.8	
F5-8	R		25.2	
F274-1	L		24.1	
F329-1	L		26	
F175-14	R		25.1	
F80-1	R	24.4		
F177-11	R	25.2		
F256-1	L	23		
SM413.501.5(20-30)-3	L		27	25
SM414.499.5-30	L	27.5		25
SM414.498.5-23	L		25.5	
SM411.508.%g-6	L		25	
SM412.502.5(30-40)-1	R		25	23
SM414.500.5(10-20)-2	R		26	23
SM414.501.5(0-10)-10	R	25.5		
SM415.499.5-2	R	23.5		19.5
SM415.5-1	R	25		21
SM408.496.17/26-1	R	23		19
SM414.499.5-3	R		26	

Capreolus capreolus
sacrum

Specimen	**HFcr**
AH98-31	11.1

Capreolus capreolus
scapula

Specimen	**Side**	**LG**	**BG**	**SLC**	**GLP**

AH1-22	R		21.7	17.3	25.7
AH88-16	L			17.2	
AH98-12	R		19.4	17.4	26
AH70-21	L			18	29.5
AH70-5	L			17.5	
AH98-10	L			18.2	27.8
AH88-19	L			16.2	
AH25-48/AH25-27	L			17	
AH98-11	L		21.4	18.6	29.9
AH70-28	R			18.9	
AH107-4	R		21.4	18.3	28.2
AH89-33/AH89-40	R				26.6
AH28-22/AH28-6	R			15.3	
F175-20	R		20.6	18.1	
F25-7	L			17.2	
F143-4	R	22.7	20.4		22.4
F79-1	L		21	18.4	
F15-2	L				
F688-1	L		21	17.2	26.7
T66-15	L			17.5	
T123-2	R			18.4	
SM411.502.26(30-40)-1	L	22	19.5	18	26
SM413.500-5(30-40)-2	L	23.5			29
SM414.499.5G-7	L	23	19	18	28
SM412.502.5(40-50)-5	L	20.5	20		27.5
SM414.497.5-12	L	20		17.5	28.5
SM414.499.x32	L	20.5	20.5	17	
SM413.501.5(0-10)-1	R	23		18	30
SM409.500.17(40-50)-1	R	20.5	20	17	26.5

SM412.500.17(+8--2)-4	R	22	21	18	27
SM414.502.5bund-6	R	22	20	16	28.5
SM414.494.5-1	R	31.5	30.5	25	
SM413.499.5-8	R	22	20.5		31.5
SM413.496.5-42	R	24	23.5		

Capreolus capreolus

tibia

Specimen	**Side**	**Bd**	**Bp**
AH12-32	L	25	
AH32-16	L	25.1	
AH7-18	L	25.7	
AH131-12	L	24.6	
AH89-14	L	29	
AH80-7	L	26.8	
AH62-33	L	28.4	
AH92-11	L		41.7
AH29-1	R		42
AH131-8	R	24.4	
AH136-18	R	26.4	
AH151-18	R	24.3	
AH93-14	R	26.2	
AH23-3	R	27.2	
AH140-16	R	26.2	
AH133-45	R	24.8	
AH77-20	R	27	
AH62-55	R	26.9	
AH66-16	R	24.9	
AH7-11	R	27.7	

AH140-38	R	26.9	
F291-1	L	26	
F5-18	R	24.1	
F25-2	L	26	
F650-1	R	26	
SM411.502.17(10-20)-2	L	27.5	
SM415.497.5-1	L	25.5	
SM414.494.5-7	L	24	
SM414.501.5(10-20)-8	R	25	
SM414.501.27(10-20)-1	R		28.5
SM414.502.5G-2	R	24.5	
SM413.497.5-5	R	26.5	
SM411.508.5G-5	R	27	
SM415.499.5G-11	R	27.5	
SM410.496.17/26-9	R	25	
SM414.498.5-8	R	27	

Capreolus capreolus

ulna

Specimen	**Side**	**SDO**	**LO**	**DPA**	**BPC**
AH1-24	L	21.6			14.4
AH62-7	L	23.9	38.2	26	14.3
AH98-54	L			24.2	
AH6-11	L	21.5	37.7	25.3	13.1
AH24-2	L			23.7	
AH102-1	R	21.4	36	24.6	14.4
AH47-3	R	20.8	36.5	24.5	14.8
AH92-73	R				14.9
AH88-17	R		37	24.2	14.1

AH100-13	R			24.8	14.4
AH39-11	R	25.8			13.9
AH7-23	R				13.5
AH131-3	R	21.1		24.5	14.3
AH93-5	R			21.4	13.9
AH70-10	R			24.6	
AH52-49	R	19.7	34.8	23.3	14.2
AH92-6	R		39.9		
F1-18	R	19.3	35.4	22.8	13.8
F22-4	R				13.7
F172-24	L				12.9
F141-22	L			26.1	
F208-9	L				13
F322-1	L	18.7	33.7	21.8	12.3
F25-12	L	20.3		23.3	12.7
F652-2	L	20.1	35.9	24.2	13.1
SM413.501.5(20-30)-8	L	22	35.5	26	14
SM412.500.5(40-40)-9	L	21	35		13.5
SM415.500.27(0-10)-1	L	2	39.5	27	13.5
SM415.502.5G-2	R	23	37	27.5	13
SM415.500.27(0-10)-3	R			23	14

Sus scrofa **astragalus**

Specimen	**Side**	**GLl**	**GLm**	**Dl**	**Bd**
AH73-16	R	46.8	42.9	23.9	29
AH40-1	R	48.4	44.7	24.6	
SM414.498.5-1		49	44		

Sus scrofa
cranium

Specimen	**34**	**36**	**37**	**38**
SM414.495.5-16	61	23	27	
414.495-5-15				70

Sus scrofa
calcaneus

Specimen	**Side**	**GB**	**GL**
F690-1	L	24	87.7

Sus scrofa
humerus

Specimen	**Side**	**Bd**	**BT**	**SD**
AH93-10	R		30.4	
AH84-1	R	44.8	35.6	
SM411.508.5G-2	L			11
SM413.502.5(30-40)-5	L	47		
SM412.496.17/26-1	L	49		
SM414.494.5-23	R			14
SM413.496.5-36	R			13

Sus scrofa
innominate

Specimen	**SB**	**SH**
F1-28	10.5	21.3

Sus scrofa
mandible

Specimen	Side	13
SM412.502.5G(10-20)-3,-4	L	132

Sus scrofa
metacarpal

Specimen	side	GL	Bp
SM413.499.5-5	L	71	
SM413.500.5(50-60)-2	L	61	
SM414.500.5(20-30)-6	R		23

Sus scrofa
patella

Specimen	GB	GL
SM416.498.5-9	25	44

Sus scrofa
radius

Specimen	Side	Bd	Bp
F234-1	L	44.7	
415.501.5-8	R		35

Sus scrofa
scapula

Specimen	Side	BG	SLC	GLP
T83-3	L	27.5		
F721-12	R		28.1	
F699-1	L		27.2	
SM411.501.17(0-10)-2	R			46

Sus scrofa

tibia

Specimen	Side	Bd
SM413.500.5(40-50)-7	L	36
SM414.500.5(20-30)-5	L	34.5
SM412.501.27(10-20)-2	L	38
SM411.502.17(10-20)-10	R	38
SM415.498.5-1	R	35

Cervus elaphus

astragalus

Specimen	Side	GLm	GLl	Dl	Bd	Dm
AH25-2	L		52.6			
AH7-1	L		47.6			
T109-8	R	44.6				
T85-5	R		59.1	31.3		
T61-1	L	47.3	50.9	28.2	33.4	
T3-31	L		49			
T121-1	L	50.2				
F282-1	R	46.1	48.6	26.2	31	
F303-1	R	47.9				
F693-1	L	47.6	49.8	27.3	30.5	
F613-1	R	43.9	45.9	25.5		
F656-1	R	47.9	50.9	27.7	33.2	
SM414.498.5-18	L	50	53	28	33	29
SM414.499.5-15	L	45	50	27	30	26
SM415.497.5-14	L	46	50	26.5	29	25
SM413.502.5(40-50)-17	L	50	51.5	28	32.5	28
SM412.501.27(10-20)-5	L	43	45.5	26	29.5	26

SM414.499.5G-15	R	51	53	28	33	29
SM410.496.27-8	R	45	47	27	31	27.5
SM413.502.5(40-50)-12	R	49	52	29	30.5	29
SM409.500.27-1	R	53.5	56	29	34	31

Cervus elaphus
calcaneus

Specimen	**Side**	**GL**	**GB**
AH136-7	L	101.5	
F676-1	L		32.9
F689-1	R		32.9
SM412.502.5(40-50)-2	L	113	35
SM413.499.5-6	L	98.5	34
SM414.494.5-14	R	101.5	29
SM415.497.8-1	R	100	33
SM413.496.5-2	R	101	
SM407.496.17/26-5	R		31

Cervus elaphus
femur

Specimen	**Bp**	**DC**
SM414.494.5-13	59	27
SM413.499.5-15	79	31
SM412.502.27(0-10)-3		33

Cervus elaphus
humerus

Specimen	**Side**	**Bd**	**BT**
SM415.498.4-4	L	51	47

SM412.500.17(+8--2)-2	L	55	47.5
SMx86	L	56	50.5
SM414.502.5-8	L	54	46.5
SM413.501.5(20-30)-1	L	48	42
SM414.501.5(0-10)-1	L	52	47
SM411.501-27(10-15)	L	50.5	45.5
SM411.496.17/26-8	R	47	41
SM409.496.17/26-1	R	51	45
SM414.500.27(10bund)-1	R	55	45.5
SM412.500.17)-1	R	50.5	46.5
SM411.500.27(10-15)-1	R	53	

Cervus elaphus

innominate

Specimen	**Side**	**SB**	**SC**
F191-6	R	14.8	22.6

Cervus elaphus

mandible

Specimen	**Side**	**9**	**15b**	**15c**
F305-4	L	49	32.4	28.1

Cervus elaphus

medial malleolus (fibula)

Specimen	**GD**
F208-13	24
F257-5	21.1
F193-11	23

Cervus elaphus
metacarpal

Specimen	Side	Bd	Bp
SM414.497.5-2	I	37	
SM414.502.5-12	L		33.5
SM414.501.27(0-10)-2	L	39	
SM412.502.5G(0-10)-3	R	35	
SM411.502.26(40-50)-1	R		39
SM415.498.507	R		33

Cervus elaphus
metatarsal

Specimen	Bd	Bp	SD	GL
SM414.502.5(0-10)-2	34.5			
SM413.500.27(10-20)-1	35.5	31.5	29	270
SM413.496.5-5	35			
SM414.497.5-1	34.5			

Cervus elaphus
naviculocuboid

Specimen	Side	GB
F694-1	R	40.8
SM414.499.5-22	L	37.5
SM414.494.5-46	L	41
SM412.500.5(0-10)-6	R	35
SM412.500.5(40-50)-2	R	40.5
SM412.502.5(0-10)-7	R	37

Cervus elaphus

radius

Specimen	Side	Bd	Bp	Bfp	Bfd
F684-12	L		54.7		
F659-1	L		50.6		
F667-2	R		46.1		
F615-2	L	43.2			
SM412.502.27(0-10)-15	L	42.5			31.5
SM414.497.5-18	L	40			32
SM414.499.x33	L		48.5	46	
SM415.498.5G-1	L		52	48	
SM409.500.27(0-10)-1	L		48	46	
SM414.501.5G-1	L	43			32
SM414.500.37(0-10)-1	R	42.5			34
SM412.501.27(10-20)-4	R	44			34

Cervus elaphus

scapula

Specimen	Side	SLC	GLP	LG	BG
AH57-16	R	28.8	51.7		
F39-4	R		51.2	37.9	
F611-1	L		47.1	37.9	
SM415.500.5-2	L	32.5	52	40	40
SM412.500.5(0-10)-1	L	26	44	34	
SM415.499.x35	L	33	53	45	36
SM414.499.27-1	R	30		38	32
SM414.4995-14	R	28.5	45	37	33
SM413.497.5-1	R	32	51	41.5	39.5
SMx67	R	30	54	38	36

Cervus elaphus
tibia

Specimen	**Side**	**Bd**	**Dd**	**Bp**
AH88-5	R	44.9	36	
AH89-26	L	46.2	36	
AH13-2	L	42.5	32	
F359-2	L	47		
F645-1	L	41.1		
F664-1	R	43.8		
F722-1	R	42.6		
SM415.499.5-7	L	42.5		
SM415.497.5-12	L	42		
SM414.494.5-10	L	44.5		
SM415.497.5-13	L	40		
SM413.497.5-7	L			62
SM414.501.5(0-10)-2	L	46.5		
SM414.502.5-9	L	44.5		
SM412.500.5(0-10)-2	L	40.5		
SM409.500.17(10-20)-2	L	40		
SM412.501.27(10-20)-2	L	41.5		
SM414.498.5G-4	R	44		
SM411.496.17/26-1	R	42		
SM414.498.5-20	R	45		

Cervus elaphus
ulna

Specimen	**Side**	**BPC**	**DPA**
SM415.496.(5G)-3	L	29.5	51
SM414.497.5-20	L		55

SM409.500.27(0-10)-2	R	26

Castor fiber
astragalus

Specimen	Side	GL
AH77-18	L	23.6

Castor fiber
calcaneus

Specimen	Side	GL	GB
AH37.5	L	49.6	18.2

Castor fiber
humerus

Specimen	Side	GL	GLl	GLC	Bp	Dp	SD	BD	BT
AH77-13/AH77-7	L	86.2	84.6	85.5	26.9	24	9.7	34.5	21.5
AH37-6	R						9.2		20.2
SM414.498.5-34	R							29	

Castor fiber
radius

Specimen	Side	Bp
AH1-44	R	12.4

Castor fiber
scapula

Specimen	Side	SLC
AH32-38	R	13.8

Canis familiaris

astragalus

Specimen	Side	GL
AH93-13	R	19

Canis familiaris

calcaneus

Specimen	Side	GL
AH85-4	L	35.9
AH93-13	R	34.3

Canis familiaris

cranium

Specimen	27	25	28	40	36	17	16	15	35
SM411.501.17(10-20)-4	16.5	34.5	12	43	40	46	17.5	61	37.5

Canis familiaris

femur

Specimen	Side	Bp	Bd	SD	GL	DC	GLC
AH24-16	R	31.7				15.3	
AH93-7	L	30.4				14.7	
SM411.500.17(10-20)-13	L	37	29.5	12	16.5	18	30

Canis familiaris

humerus

Specimen	Side	Bp	BT
AH43-13	L		19.5
AH84-57	L	24.7	

Canis familiaris

innominate

Specimen	Side	SH	SB	LAR
AH84-77/AH84-109	R	14.4	7.6	
SM411.500.17(10-20)-14	L			21

Canis familiaris

mandible

Specimen	side	1	2	3	4	5	6	7	8	9	10	11	12	13
SM411.501.17(10-20)-2	L	143	140	132	121	111.5	119	75	71	65	33.5	37.5	34	19
SM411.501.17(10-20)-14	L													

Canis familiaris

radius

Specimen	Side	BP	Bd
AH84-148	L	14.1	
AH6-21	R	16.7	
AH24-1	R		24.2

Canis familiaris

tibia

Specimen	Side	Bd	SD	Bp	GL	Dd
AH6-24	R					15.3
AH12-27	R	20.5				14.4
AH36-53	L					14.8
AH62-103	L	20				14.3
AH83-42	L	19				13.2
SM411.501.17(10-20)-3	L	21	12.5	32	166	15.5
SM412.502.5G(0-10)-4	R	18	10.5			13.5

Canis familiaris

ulna

Specimen	Side	SDO	DPA	BPC
AH68-9	L			12.7
AH90-22	L	17.4	21.1	14
AH24-58	R	18.5	21.8	12.7

Felis silvestris

metacarpal

Specimen	side	Bd	Bp	SD	GL
SM411.502.17(10-20)-13	L	5.5	6	3	33

Felis silvestris

metatarsal

Specimen	side	Bd	Bp	SD	GL
SM410.500.17-1	L	7	8	5.5	60
SM410.500.17(0-10)-5	L	7	5	4	55
SM410.500.17(10-20)-3	L	5.5	8	3	57
SM411.500.17(10-20)-24	R	7	8	5.5	60
SM412.500.17(+8--2)-9	R	6	5	4	55

Felis silvestris

tibia

Specimen	Side	Bp	Bd
AH100-56	L	21.9	
SM411.502.17(10-20)-14	L		13.5
SM415.497.5-6	L		17

Lutra lutra
atlas

Specimen	BFcr
AH131-24	32.1

Lutra lutra
femur

Specimen	side	Bd	Bp	SD	GLC	DC	GL
SM414.495.5-1	R	25.5	26	9	92	12	90

Lutra lutra
humerus

Specimen	Side	GL	SD
SM414.496.5-1	R	90	7

Lutra lutra
mandible

Specimen	Side	5	8	9	10	13	14	19
AH108-1	R					14.1		
AH132-91	L					13.2	13.1	11.5
SM413.500.27(10-20)-4	L	52	33	30	15			
SM413.500.27(10-20)-3	R	52	34	31	14.5			

Lutra lutra
metapodial

Specimen	side	Bp	Bd	SD	GL
SM412.502.5G(10-20)-12	I	4.5	5.5	3.5	25.5
SM414.498.5-66	I	7			

Lutra lutra
radius

Specimen	Side	Bp
SM413.501.5(30-40)-7	L	12

Lutra lutra
sacrum

Specimen	GB	GL	PL	HFcr	BFcr
SM413.500.5G	48	50	46	10	19

Martes martes
atlas

Specimen	BFcr	BFcd	Lad	H
AH36-68	21.4	14.3	6.7	12.5
AH7-37		13.9	6.5	11.8

Martes martes
axis

Specimen	BFcr	SBV
AH36-73	12.7	10

Martes martes
humerus

Specimen	Side	Bd	BT
AH98-82	L	16.1	10.8
AH71-12	R	15.2	11.2

Martes martes
innominate

Specimen	Side	SH	SB
AH29-15	R	8.5	4.1
AH28-33	R	8.6	4.3
AH12-30	R	9.3	4.3
AH36-94	L	8.1	4.2
AH84-163	L	8.5	3.4

Martes martes
mandible

Specimen	Side	11	12	13	14	17	19	20
AH72-18	L		15.9	11	10.7	4.7	9.6	9.4
AH132-45	R	18.8	16.3	10.8	11	5.6	11.4	10.5
AH77-41	L						10.1	
AH93-19	R					5	9	
AH52-63	L							9.5
AH106-1	R			9.5	9.7	5	10	8.8
AH47-9	R							8.7

Martes martes
radius

Specimen	Side	Bp	Bd
AH57-4	L		9.1
AH83-103	L	6.3	
AH134-11	R		8.3
AH107-55	R		8.3
AH131-112	R	6.7	
AH73-42	R	6.2	

Martes martes

tibia

Specimen	Side	Bp
AH136-25	R	14.7

Martes martes

ulna

Specimen	Side	SDO	BPC
AH92-57	L	7.8	7.3

Vulpes vulpes

calcaneus

Specimen	Side	GL	GB
AH1-58	L	32	11.4
F364-1	R	32.7	13.3
F163-29	L	30.5	12.7

Vulpes vulpes

femur

Specimen	Side	GLC	DC	SD	Bd
AH1-26	R	121.4	12.3	8.9	21

Vulpes vulpes

innominate

Specimen	Side	LAR	SH	SB
F196-8	L		11.7	5.2
F336.1	R	12.9		

Vulpes vulpes

mandible

Specimen	Side	19
AH137-5	L	14
AH61-10	R	13.9

Vulpes vulpes
radius

Specimen	Side	BP	SD
AH140-6	R	11.5	
AH82-22	R	11.4	
F176-10	L		7.8

Vulpes vulpes
scapula

Specimen	Side	SLC	GLP	BG
AH84-70	L	14.1	17.3	10.9
AH132-103	R		17.2	

Vulpes vulpes
tibia

Specimen	Side	Bd	Dd
AH136-8	R	14.7	10.4

Vulpes vulpes
ulna

Specimen	Side	DPA	SDO	BPC
AH131-53	R	14.1	13.5	9
AH82-2	R	15.4	13.5	9.4
AH140-26	L	16.5	13.2	9.3
F176-6	L		13.7	

Appendix III-Measurements of the Havnø Fauna

All measurements follow von den Driesch 1976, single underscore is *Bos taurus*, double underscore is *Bos primigenius*

***Bos* sp.**
Astragalus

Specimen	Side	GLl	GLm	Dl	Dm	Bd
H-ADLO	L	61.21	57	34.1		
H=XYO-8	R	68.3	61.7	37.3		43.6
H=AJR	R	68.3	62.1	37.1		
H=GV-1	R					41.7
H=AHS	L	70				
H=EPA	L	68.2		38.1		

***Bos* sp.**
Calcaneus

Specimen	Side	GL
X-XYO-9	R	135

***Bos* sp.**
femur

Specimen	Side	DC
H-JFW	R	45.6

***Bos* sp.**
1st Phalanx

Specimen	Age	Side	SD	Glpe	Bp
H-AHBW	Juvenile	R/Pair	20.6		
H-XZM	Juvenile	R/Pair	21.9		
H-QAO-2	adult	L/pair	26		
H-MMJ	adult	L/pair	26.1		32.1

H-QBE	adult	R/Pair	25.5	57	29.5
H=OE	adult	L/pair	24		
H=AJV	adult	L/pair	33	70.3	41.6

***Bos* sp.**

4th carpal

Specimen	Side	GB
H=ANH	L	29.7

***Bos* sp.**

Lateral malleolus

Specimen	Side	GD
H-XYO-11	R	32.1
H-AGAD-1	L	30.8
H-XKM	L	36.1
H=ABJ-3	R	30.7
H=EOB-1	L	32

***Bos* sp.**

metacarpal

Specimen	Side	Bp
H-MBP	L	60.6

***Bos* sp.**

Metatarsal

Specimen	Bp	Dp
H=HH-3	45.2	
H=BKC		45.2

***Bos* sp.**
Naviculocuboid

Specimen	Side	GB
H=CN-3	R	51.1

***Bos* sp.**
Radius

Specimen	Side	Bd
H=AJH	L	69.3

***Bos* sp.**
scapula

Specimen	Side	GLP	LG	SLC	BG
H-MMP	R	75.2			47.8
H-XSO	R			44.3	

***Bos* sp.**
2nd phalanx

Specimen	Side	GL	Bp	SD	Bd
H-YQO	R/pair	39.7	28.1	21.7	
H-MFS-3	L/pair	38.1	31.8	24.2	
H-MMH	L/pair			23.6	
H-MLV	L/pair		31.1	23.6	
H-MGE	R/pair		28.1	30	
H=GBX	L/pair	44.6	32.9	25.6	27.2

***Bos* sp.**
2+3 carpal

Specimen	Side	GB

H-MAW	L	34.2
H-ABFZ	R	34.4
H=DMF	L	34.8

***Bos* sp.**

3rd Phalanx

Specimen	Side	MBS
H=CK-1	R/pair	21.5

***Bos* sp.**

Tibia

Specimen	Side	Bd	Dd	SD
H-XYO-7	R	62.4	46.4	
H=EOB-6	L	60.8	47.8	37.2
H=JH	L	63.2	47.7	
H=ANU	R	59.5	45.6	

Capreolus capreolus

astragalus

Specimen	Side	Dl
H-PKF	L	15.6
H-MMN	R	15.9

Capreolus capreolus

1st phalanx

Specimen	Side	BP
H=CQ-2	L/pair	11.5
H=CQ-4	L/pair	11

Capreolus capreolus

metatarsus

specimen	**side**	**BP**
H=OM	R	21.8

Canis familiaris

femur

Specimen	**Side**	**Bd**
H=ST-1	R	25.5

Canis familiaris

humerus

Specimen	**Side**	**Bd**
H-PLU	R	26.5

Canis familiaris

mandible

Specimen	**Side**	**13**	**14**
H-TKE	R	17.7	16.5

Canis familiaris

tibia

Specimen	**Side**	**Bp**	**SD**	**Bd**	**Dd**
H-UAD	L	25.6			
H=BDQ/ANM		13.7	12.4	22.2	15.2

Canis familiaris

ulna

Specimen	**Side**	**LO**	**DPA**	**SDO**	**BPC**

H-NHK	L	25	19.3	17.3	13.6

Capra hircus
astragalus

Specimen	**Side**	**GLm**	**Dl**	**Bd**
H=EPK	R	27.6	15.5	20.2

Capra hircus
naviculocuboid

Specimen	**Side**	**GB**
H=FCB	L	22.9

Capra hircus
tibia

Specimen	**Side**	**SD**	**Bd**	**Dd**
H-ADFQ	R	13.6	22.8	17.6
H-ADGK	L	12.2		17.8

Castor fiber
tibia

Specimen	**Bd**	**Dd**
H-PBX	20.8	18

Cervus elaphus
astragalus

Specimen	**Side**	**GLl**	**GLm**	**Dl**	**Dm**	**Bd**
H-RYS	R	59.4	55.4	33.8	32.3	38.7

Cervus elaphus

atlas

Specimen	BFcd
H-JSZ	73.6

Cervus elaphus

Carpal 2 + 3

Specimen	Side	GB
H=EAK-6	R	24.6

Cervus elaphus

Carpal 4

Specimen	Side	GB
H=EAK-5	R	19.7

Cervus elaphus

1st Phalanx

Specimen	Side	GL	Bp	Sd	Bd
H-VXW	L/pair	47.3	22.7	17.3	18.5
H=JE	L/pair		22.9		

Cervus elaphus

humerus

Specimen	Side	BT
H-POG	L	61.5

Cervus elaphus

Metacarpal

Specimen	Side	Bp
H=BGK	R	41.2

Cervus elaphus

radius

Specimen	**Side**	**Bd**	**BFp**	**BP**
H-MMD-4	R	51.6		
H-ADOK	L		51.8	54.3

Cervus elaphus

Scapula

Specimen	**Side**	**SLC**	**GLP**
H=AHB	L	42.7	59.2
H=DA-4	L		

Cygnus cygnus

humerus

Specimen	**Bd**	**SC**
H=DAW		16.2
H-HWV		16.9
H-RFR-3	31.5	
H-LQH	31.8	

Cygnus cygnus

Scapula

Specimen	**DiC**
H-ADFU-3	24.7
H-ADDV-2	25.6
H-ADED	26.2

Cygnus cygnus

tibiotarsus

Specimen	**SC**
H-HSF	12.7
H-MFL	12.6

***Cygnus* sp.**
Humerus

Specimen	**SC**
H-BKF	17.3
H-AHK-1	17.1

***Cygnus* sp.**
radius

Specimen	**SC**
H=BKU	11

***Cygnus* sp.**
Scapula

Specimen	**DiC**
H=OT	22.6
H=PT	25.4

Lutra lutra
humerus

Specimen	**Dp**
H=EGY-1	18.9

Lutra lutra
radius

Specimen	GL	Ll	BP	SD	Bd
H=EQO	59.1	60.6	12.3	5.5	13.6

Ovis aries
humerus

Specimen	SD	BT	Bd
H-MFV		27.2	
H-ADBE	13.3	25.2	
H-MFV		27.4	28.3
H-ADFZ	13.3		

Ovis aries
radius

Specimen	Side	BP	BFp	SD	Bd	BFd
H=ECA	L	30.2	28.1	15.2	27.3	21.8

Ovis aries
tibia

Specimen	Side	SD	Bd	Dd
H=DFK	R		24.6	18.9
H=FHO	L	13	24	18.8

Sus scrofa
astragalus

Specimen	Side	GLl	GLm	Dl	Dm	Bd
H-MLZ-2	R		41.8			
H-POW	R	47.2				
H=EKX-1	L	58.6	52.7	30.8	38	
H-AEBT-2	R	46.8	42			27.1

Sus scrofa

1st Phalanx 3 or 4

Specimen	**Side**	**Bp**	**Bd**
H-YXA	R/pair	17.8	
H-XUZ-1	L/pair	15.3	
H-YXX	R/pair		16.8
H-AHBP	R/pair		16.4

Sus scrofa

Metacarpal 3

Specimen	**Side**	**Bp**
H-AHBB	R	18.6
H-AELN	L	20.1
H-AGKQ	L	22.1

Sus scrofa

Metatarsal 3

Specimen	**Side**	**Bp**
H-ADFD	R	17.2
H-AEBG-1	L	15

Sus scrofa

Metatarsal 4

Specimen	**L**	**Bp**
H-AGEJ	L	17

Sus scrofa

Patella

Specimen	Side	GB
H=DF-5	L	24.8

Sus scrofa
scapula

Specimen	Side	SLC	GLP	LG
H-XOL	R	16		
H-UCC	L	24.2		
H-NNC	L	24.8	39	33.8

Sus scrofa
3rd phalanx 3 or 4

Specimen	Side	GL	Bp	SD	Bd
H=EOG-2	R/pair	42	19.5	15.1	17.6
H=AD-10	R/pair		18.9		

Sus scrofa
tibia

Specimen	Side	Bd	Dd
H-JHR	L	25.9	23.5

Vulpes vulpes
tibia

Specimen	Bd
H=AO-8	14.6

Appendix IV : Asnæs Havnemark Bag Proveniences

Bag Number	Square	Level	Trench	Date	Excavator	Other
1	126E135N	ShCuLayer	TR3	4-Jul-07	VLS	
2	124E136N	Beach Sand	TR3	12-Jul-07	TDP	
3	126E132N		TR1	26-Jun-07	TLS	grey below culture layer
4	122E135N	BrCuLayer	TR3	7-Jul-07	LRA	
5	120E136N		TR3	6-Jul-07	TLS	Fine grey sandy deposit
6	123E134N	UBrSand		7/7/2007	TDP	
7	126E133N	BrCuLayer	TR1	27-Jun-07	TLS	
8	126.15E130.60N	Grey CuLayer	TR1	26-Jun-07	JN	x2
9	122E134N		TR3	7/11/2007	VLS	Brown Culture Layer Bag 1 of 2
10	124E136N	BrCuLayer	TR3	12-Jul-07	TDP	
11	125E133N		TR1	28/6/07	VLS	grey layer beneath culture layer
12	122E134N	BrCuLayer	TR3	11-Jul-07	VLS	
13	126E133N		TR1	28-Jun-07	TLS	grey below CuLayer
14	124E134N	LBrSurface	TR3	11-Jul-07	TDP	
15	120E136N	LightBrSurface	TR3	13-Jul-07	TLS	
16	124E133N		TR1	29-Jun-07	VLS	grey beneath culture layer
17	125E132N		TR1	25-Jun-07	TLS	Grey below culture layer
18	120E136N	BrSurf		11/7/2007	TLS	teeth
19	123E134N	UBrSand		7/7/2007	TDP	2x bone
20	124E132N		T1	6/27/2007	TLS	gray below culture
21	124E134N	UBrLayer	TR3	11-Jul-07	TDP	
22	128E135N		TR3	4-Jul-07	VLS	grey below CuLayer
23	126E130N	Grey CuLayer	TR1	26-Jun-07	JN	
24	124E133N	BrCuLayer	TR1	29-Jun-07	JN	
25	122E136N	BrShell	TR3	17-Jul-07	LRA	
26	125E133N		TR1	26-Jun-07	VLS	on top of grey layer under "culture

						layer"
27	124E132N	DkBrCuLayer	TR2	27-Jun-07	TLS	
28	123E136N	BrShell	TR3	16-Jul-07	KJG	
29	124E136N	BrShell	TR3	17-Jul-07	KJG	
30			TR3	20-Jul-07	TLS	South wall, loose finds
31	122E135N	Shell	TR3	11-Jul-07	LRA	
32	122E136N	BrSand	TR3	13-Jul-07	LRA	
33	122E135N	BrSurface	TR3	12-Jul-07	LRA	
34	130E129N			19-Jun-07	KCR	Test Pit #1
35	123E135N	BrSand			KJG	
36	119E134N	Feature A8	TR3	20-Jul-07	JN	Pit fill
37	128E135N	BrSand	TR3	3-Jul-07	VLS	
38	122E134N	BrSurface	TR3	13-Jul-07	VLS	
39			TR1		JN	backdirt. CuLayer with Shell
40	130E135N	Lbeach	TR3	3-Jul-07	LRA	
41	136E132N	CuLayer	TR2	25-Jun-07	LRA	
42	150E119N			19-Jun-07	TLS	Test 3
43	134E135N	CuLayer	TR3	3-Jul-07	KCR	
44	123E134N	UBeach		8/7/2007	TDP	bone
45	123E136N	Ubeach		7/7/2007	KJG	
46	120E136N	BrSurface	TR3	11-Jul-07	TLS	
47	121E134N		TR3	20-Jul-07	VLS	bottom pit fill shell below Feature A7
48	121E134N		TR3	19-Jul-07	VLS	bottom pit fill below feature A7. no shell
49	134E132N	Culture Layer	TR2	22-Jun-07	KCR	
50	134E133N	Culture Layer	TR2	25-Jun-07	KCR	
51	120E136N	BrSurface w/ shell	TR3	11-Jul-07	TLS	
52	123E134N	CuLayer	TR3	7-Jul-07	TDP	
53			TR2	22-Jun-07	LRA	Loose Finds
54	125E131N	CuLayer	TR1	22-Jun-07	KJG	

55	119E134N	BrSand	TR3	19-Jul-07	JN	
56	125E135N	BrSand	TR3	2-Jul-07	TDP	BrSand over ShCuLayer
57	124E136N	BrSurface		7/17/2007	KJG	
58	118E135N	BrSurface	TR3	11-Jul-07	JN	
59	122E135N	CuLayer	TR3	5-Jul-07	LRA	2 of 4
60	130E135N	CuLayer	TR3	2-Jul-07	LRA	
61	121E134N		TR3	18-Jul-07	VLS	Feature A7 upper layer
62	124E135N	Shell	TR3	19-Jul-07	KCR	
63	118E134N	BrSand	TR3	16-Jul-07	JN	
64	134-136E131-132N		TR2	28-6-07	KCR	all layers below culture layer
65	119E134N	BrSand	TR3	20-Jul-07	JN	
66	121E134N	BrSurface	TR3	18-Jul-07	VLS	
67	123E136N	BrSand	TR3	11-Jul-07	KJG	
68	121E134N		TR3	19-Jul-07	VLS	feature A7 lower layer
69	123E135N	BrSurface	TR3	6-Jul-07	KJG	
70	122E136N	CuLayer	TR3	16-Jul-07	LRA	
71	121E134N		TR3	19-Jul-07	VLS	bottom pit fill shell below feature A7
72	124E136N	Shell	TR3	13-Jul-07	TDP	
73	125E132N	CuLayer	TR1	22-Jun-07	TLS	
74	120E136N	BrSurface	TR3	11-Jul-07	TLS	
75	123E136N	BrSand	TR3	11-Jul-07	KJG	
76	122E135N	BrSurface	TR3	7-Jul-07	LRA	
77	128E135N	CuLayer	TR3	2-Jul-07	VLS	
78	125E135N	BrSurface	TR3	4-Jul-07	LRA	
79	135E133N	Culture Layer	TR2	26-Jun-07	KCR	
80	126E135N	BrSurface	TR3	5-Jul-07	VLS	
81	120E134N	BrSurface	TR3	16-Jul-07	VLS	
82			TR3	17-Jul-07	TLS	South wall, Loose finds
83	125E133N	CuLayer	TR1	25-Jun-07	VLS	

84	123E135N	CuLayer	TR3	3-Jul-07	KJG	
85	123E136N	BrSurface	TR3	16-Jul-07	KJG	
86	122E134N	CuLayer	TR3	7-Jul-07	VLS	
87	125E128N	CuLayer	TR1	21-Jun-07	TLS	
88	118E134N	BrSurface	TR3	16-Jul-07	JN	
89	136E133N	CuLayer	TR2	26-Jun-07	LRA	
90	122E136N	BrSurface	TR3	18-Jul-07	LRA	
91	124E135N	Shell	TR3	17-Jul-07	KCR	
92	123E136N	Shell	TR3	12-Jul-07	KJG	
93	120E136N	BrSurface	TR3	6-Jul-07	TLS	
94	123E136N	CuLayer	TR3	11-Jul-07	KJG	
95	136E133N	Culture Layer	TR2	25-Jun-07	LRA	
96	150E110N			19-Jun-07	KG	Test #6
97	123E135N	UBeach	TR3	2-Jul-07	KJG	
98	122E135N	CuLayer	TR3	5-Jul-07	LRA	
99	123E135N	Shell	TR3	2-Jul-07	KJG	
100	123E135N	Shell	TR3	2-Jul-07	KJG	
101	122E136N	CuLayer	TR3	160707	LRA	
102	124E135N	BrSurface	TR3	19-Jul-07	KCR	96l
103	128E135N	BrSand	TR3	7/3/2007	VLS	
104	140E119N	All Levels		18-Jun-07		Test Pit #2
105	128E135N	UBeach	TR3	2-Jul-07	VLS	
106			TR1	21-Jun-07	VLS	loose
107	125E135N	Shell	TR3	3-Jul-07	TDP	
108		culture layer 2	TR2	29-Jun-07	KCR	north end, 2.0x0.3m, bottom of trench
109	126E132N	Culture Layer	T1	26-Jun-07	TLS	
130	119E134N	UBeach		18-Jul-07	JN	
131	120E135N	BrSurface	TR3	4-Jul-07	TLS	
132	124E135N	CuLayer	TR3	13-Jul-07	KCR	144l

133	123E134N	BrSand	TR3	6-Jul-07	TDP	
134	136E131N	CuLayer	TR2	28-Jun-07	LRA	see T8
135	118E134N	BrSurface	TR3	16-Jul-07	JN	
136	125E135N	Shell	TR3	3-Jul-07	TDP	
137	126E129N	BrSurface	T1	25-Jun-07	JN	
138	135E132N	CuLayer	TR2	25-Jun-07	KCR	
139	132E135N	Cultural Layer		7/2/2007	KG	
140	122E134N	CuLayer	TR3	7-Jul-07	VLS	
141	118E135N	BrSurface	TR3	11-Jul-07	JN	
142	122E134N	UBeach	TR3	6-Jul-07	VLS	
143	132E135N	LBeach	TR3	2-Jul-07	KJG	
144	122E134N	BrSand	TR3	11-Jul-07	VLS	
145	125E135N	BrSand		3/7/2007	TDP	
146	122E135N	BrSurface	TR3	6-Jul-07	LRA	1 of 2
147	120E136N	UBeach	TR3	5-Jul-07	TLS	
148	125E129N		TR1	21-Jun-07	KJG	
149	126E131N	CuLayer	TR1	25-Jun-07	KJG	
150	123E135N	CuLayer	TR3	4-Jul-07	KJG	5 of 5
151	126E131N	BrSurface	TR1	25-Jun-07	KJG	west 1/2
152	131E135N	CuLayer	TR3	3-Jul-07	LRA	
153	130E129N			20-Jun-07	KCR	Test Pit #1 bottom
154	122E136N	Brown Sand	TR3	13-Jul-07	LRA	
155	125E135N	Shell	TR3	3-Jul-07	TDP	

Appendix V:Fårevejle Bag Proveniences

Bag Number	Square	Level	Trench	Excavator	Date	other
1	140E113N	5	1	KCR	10-Aug-04	
2	141.85E110.80N	sub midden-7cm	1	KCR	20-Aug-04	X301
3	141E122N	dark grey yellow sand			20-Aug-04	
4	141.77E112.40N	base of midden	1	LRA	19-Aug-04	X300, Z=3.585
5	141E110N	5	1	TLS	26-Jul-04	
6	141E113N	6	1	KCR	30-Jul-04	
7		below midden	1	CF	1-Aug-05	
8	loose finds		1		2005	
9		below midden	1	KCR	5-Aug-05	
10	114N133E	dark lag with many pebbles below A36	2		4-Aug-05	
11	141E110N	black lag and below	1	CF	1-Aug-05	
12	140E109N	below midden	1	CF	1-Aug-05	
13	132E115N	brown tacky layer	2	TLS	3-Aug-05	
14	133E112N	oyster to "floor"	2	CF	4-Aug-05	
15	141E108N	6c	1	TLS	15-Jul-05	
16	140E108N	1	1	CF	7-Jul-05	
17	132E114N	brown crushed shell	2	LRA	4-Aug-05	
18	133E113N	sand above moraine #1	2	CF	9-Aug-05	X598
19	133E118N	skallag and dyregang	2	JN	11-Jul-05	
20	133E114N	sand above moraine	2	TLS	5-Aug-05	
21	113N113E	oyster	2	CF	8-Aug-05	
22	116N132E	top shelf layer	2	MJ	11-Jul-05	
23	132E113N	oyster heap 2	2		5-Aug-05	
24	132E113N	404/396	2	PP	Jul-05	
25	132E112N	2	2	PN	21-Jul-05	

26	140E108N	6c "1"	1	CF	18-Jul-05	
27	141E108N	5		TLS	14-Jul-05	
28	132E112N	1		PN	19-Jul-05	
29	132E115N	416/404	2	PP	21-Jul-05	
30	141E	under midden mottled clay/sand	1	CF	2-Aug-05	
31	140E109N	6f	1	KCR	20-Jul-05	
32	132E112N	1	2	PN	26-Jul-05	
33	132E115N	brown sandy shell	2	TLS	2-Aug-05	
34	132E112N	1		PN	18-Jul-05	
35	132E116N	sand above moraine	2		9-Aug-05	
36	132E144N	441/415		PP and JN	21-Jul-05	skaller over oysters, felt 2
37	132E116N	oyster heap #1	2	TLS	1-Aug-05	
38	140E109N	4	1	KCR	13-Jul-05	
39		under midden, brown mottled clay	1	CF	1-Aug-05	
40	141E108N	7	1	TLS	20-Jul-05	
41	133E114N	brown crushed shell	2	LRA	4-Aug-05	
42	113N133E	crushed shell above oyster	2	CF/TLS	5-Aug-05	
43	113N132E	brown crushed shell	2	CF	8-Aug-05	
44	132E113N	417/410			25-Jul-05	
45	140E109N	6 arbitrary	1	KCR	15-Jul-05	
46	113N132E	sand above moraine #1	2	CF	8-Aug-05	
47	133E118N	below midden	2	KCR	9-Aug-05	
48	132E115N	400/396		JN	26-Jul-05	under A33, felt 2
49	140E108N	2	1	CF	11-Jul-05	
50	133/112	oyster	2	CF	4-Aug-05	
51	140E108N	6a1	1	CF	18-Jul-05	
52	140E108N	7	1	CF	21-Jul-05	
53	140E109N	1	1	KCR	8-Jul-05	
54	132E114N	sand above moraine	2	TLS	5-Aug-05	

55	141E109N	6e	1	LRA	18-Jul-05	
56	132E115N	424/416	2	PP	21-Jul-05	
57	133E112N	2	2	PN	25-Jul-05	
58	140E108N	4	1	CF	13-Jul-05	
59	140E111N	2	1	CF	3-Aug-05	found in X bag. Not the X. X133
60	132E113N	top layer	2	PN	22-Jul-05	
61	140E108N	3	1	CF	13-Jul-05	
62	140/108	below midden	1	CF	1-Aug-05	
63	109N141E	7	1	LRA	21-Jul-05	
64	113N133E	oyster	2	CF	5-Aug-05	
65		below midden	1	KCR	3-Aug-05	
66	141E108N	6d		TLS	15-Jul-05	
67	112N132E	sand above 2nd shell below "moraine" or	2		9-Aug-05	
68	140E109N	8	1	KCR	22-Jul-05	
69	133E113N	410/404			26-Jul-05	
70	133E116N	oyster heap 1	2	TLS	2-Aug-05	
71	140E108N	4	1	CF	13-Jul-05	
72	133E112N	oyster	1	CF	4-Aug-05	3.88MOH
73	141/109	below midden	1	CF	1-Aug-05	
74	140E109N	5b	1	KCR	18-Jul-05	
75	140E108N	8	1	CF	22-Jul-05	
76	133E113N	404/396	2	P	26-Jul-05	
77	140E108N	loose 5 and below	1	CF	15-Jul-05	
78	141E108N	7b	1	TLS	21-Jul-05	
79	112N132E	oysters below "moraine"	2	CF	9-Aug-05	
80	132E115N	brown tacky layer	2	TLS	3-Aug-05	
81	132E112N	1	2	PN	20-Jul-05	
82	116N133E	top shell layer			11-Jul-05	
83	141E109N	4	1	LRA	12-Jul-05	

84	132E118N	oyster shell heap #2		MJ	26-Jul-05	
85	132E113N	brown crushed shell	2	TLS	5-Aug-05	
86	115N132E	top broken shell layer 1			20-Jul-05	
87	140E108N	6c2	1	CF	19-Jul-05	
88	140E108N	6b	1	CF	15-Jul-05	
89	132E113N	top layer	2	PN	22-Jul-05	
90	133E115N	416/404		PP and JN	21-Jul-05	knuste skaller
91	112N132E	oyster	2	CF	8-Aug-05	
92	140E108N	7b	1	CF	22-Jul-05	
93	113N133E	crushed shell	2	CF	8-Aug-05	
94	133E115N	3,99/3,94		JN	26-Jul-05	
95	132E113N	shell layer above clay	2		10-Aug-05	
96	141E109N	6e	1	LRA	18-Jul-05	
96	140E141E	under midden to bottom of black clay	1	CF	4-Aug-05	
97	132E116N	brown sandy shell	2	TLS	2-Aug-05	
98	141E109N	6f	1	LRA	20-Jul-05	
99	132E112N	oysters below "moraine"	2	CF	8-Aug-05	
100	133E118N	skaller over oysters	2	JN	12-Jul-05	
101	132E112N	2	2	PN	20-Jul-05	
102	132E114N	brown crushed shell	2	LRA	4-Aug-05	
103	133E112N	2	2	PN	26-Jul-05	
104	113N133E	sand above moraine #1	2	CF	8-Aug-05	
105	133E115N	438/424	2	PP	20-Jul-05	
106	112N133E	sand above moraine #1		CF	1-Aug-05	
107	132E115N	sand above moraine	2		9-Aug-05	
108	140E109N	3	1	KCR	12-Jul-05	
109	112N133E	sand above moraine #1 and oyster below (spyhole)	2	CF	8-Aug-05	
110	132E112N	oyster	2	CF	4-Aug-05	
111	133E115N	under A33, 400/396		JN	26-Jul-05	felt 2

112	133E113N	midden bottom pit to N (cont)	2	KCR	9-Aug-05	
113	140E108N	below midden black lag and under	1	CF	1-Aug-05	
114	117N132E	top shell layer	2	MJ	15-Jul-05	
115	117N133N	oyster shell heap #2			26-Jul-05	
116	140E108N	6a2	1	CF	18-Jul-05	
117	112N133E	sand above moraine #1	2	CF	9-Aug-05	
118	141E109N	1	1	LRA	7-Jul-05	
119	133E115N	424/416	2	PP	20-Jul-05	
120	140E108N	5	1	CF	14-Jul-05	
121	132E118N	oyster shell heap #2			26-Jul-05	
122	141E109N	2	1	LRA	11-Jul-05	
123	133E114N	broken shell, top layer			20-Jul-05	
124	132E114N	brown crushed shell	2	LRA	4-Aug-05	
125	141E108N	4		TLS	13-Jul-05	
126	132E112N	1: brown sand gravel		TDP	13-Jul-05	
127	140E108N	7 oyster lag	1	CF	20-Jul-05	
128	132E112N	oyster	2	CF	4-Aug-05	around 3.99MOH
129	132E114N	black sooty cobble		TLS	3-Aug-05	
130	133E115N	brown tacky	2	TLS	3-Aug-05	
131	141E108N	7	1	TLS	21-Jul-05	X509
132	141E109N	7b/8	1	LRA	22-Jul-05	
133	133E115N	sand above moraine	2		8-Aug-05	
134	140E109N	2	1	KCR	12-Jul-05	
135	140E109N	7	1	KCR	20-Jul-05	
136	141E109N	1	1	LRA	7-Jul-05	
137	112/133	lower level, sand/shell above moraine	2	CF	9-Aug-05	
138	133E112N	1	2	PN	25-Jul-05	
139	133E113N	top layer	2	PN	22-Jul-05	
140	141E109N	5	1	LRA	15-Jul-05	

141	140E110N	7	1	TLS	10-Aug-04
142	141E113N	4	1	KCR	26-Jul-04
143	141E112N	5	1	BO	29-Jul-04
144	140E112N	4	1	BO	11-Aug-04
145	141E107N	5	1	TB	13-Aug-04
146	140E107N	6	1	TB	29-Jul-04
147	140E110N	6	1	TLS	9-Aug-04
148	140E107N	5	1	TB	29-Jul-04
149	140E113N	1	1	KCR	2-Aug-04
150	111N141E	1	1	CF	26-Jul-04
151	114N140E	5	1	LRA	3-Aug-04
152	111N140E	2	1	CF	3-Aug-04
153	141E113N	3	1	KCR	22-Jul-04
154	141E112N	8	1	BO	20-Jul-04
155	141E114N	5	1	LRA	27-Jul-04
156	140E113N	4	1	KCR	5-Aug-04
157	111N141E	5	1	CF	28-Jul-04
158	140E113N	7	1	KCR	12-Aug-04
159	111N141E	6	1	CF	29-Jul-04
160	111N141E	3	1	CF	29-Jul-04
161	141E114N	6	1	LRA	29-Jul-04
162	141E110N	9	1	TLS	29-Jul-04
163	140E112N	7	1	BO	13-Aug-04
164	140E110N	4	1	TLS	5-Aug-04
165	141E106N	2	1	TA	3-Aug-04
166	141E107N	1c	1	Kasper	6-Aug-04
167	141E107N	4	1	TB	6-Aug-04
168	141E106N	6	1	TIA	13-Aug-04
169	141E111N	3	1	CF	22-Jul-04

170	111N140E	5	1	CF	6-Aug-04	
171	141E111N	1	1	CF	20-Jul-04	from screen
173	141E107N	5	1	TB	12-Aug-04	
174	111N140E	3	1	CF	3-Aug-04	
175	141E112N	4	1	BO	29-Jul-04	
176	141E110N	3	1	TLS	20-Jul-04	
177	140E112N	8	1	BO	13-Aug-04	
178	140E113N	8	1	KCR	12-Aug-04	
179	140E112N	6	1	BO	12-Aug-04	
180	111N141E	4	1	CF	28-Jul-04	
181	140E110N	6	1	TLS	9-Aug-04	
182	140E107N	2	1	TIA	23-Jul-04	
183	111N140E	9	1	CF	10-Aug-04	
184	141E110N	4	1	TLS	23-Jul-04	
185	141E112N	9	1	BO	3-Aug-04	
186	111N140E	4	1	CF	6-Aug-04	
187	111N141E	3	1	CF	23-Jul-04	around 2,3 on "drawing", same 5-10cm
188	141E113N	7	1	KCR	17-Aug-04	
189	141E111N	2	1	CF	20-Jul-04	
190	140E107N	4	1	TB	29-Jul-04	
191	140E112N	9	1	BO	17-Aug-04	
192	140E110N	4	1	TLS	5-Aug-04	
193	111N140E	7	1	CF	6-Aug-04	
194	111N141E	4	1	CF	26-Jul-04	
195	116N140E	2	1	LRA	17-Aug-04	
196	140E112N	3	1	BO	11-Aug-04	
197	141E113N	7	1	KCR	3-Aug-04	
198	141E112N	3	1	BO	27-Jul-04	
199	115N141E	5	1	LRA	10-Aug-04	

200	140E110N	5	1	TLS	6-Aug-04	
201	141E110N	8	1	TLS	29-Jul-04	
202	141E115N	4	1	LRA	5-Aug-04	
203	141E107N	2	1	TB	11-Aug-04	
204	140E106N	2	1	TB	30-Jul-04	
205	141E106N	4	1	TA	6-Aug-04	
206	141E112N	2	1	BO	22-Jul-04	
207	141E107N	3	1	TB	11-Aug-04	
208	141E112N	3	1	BO	27-Jul-04	
209	141E110N	6	1	TLS	28-Jul-04	
210	140E106N	4	1	TB	3-Aug-04	
211	111N141E	6	1	CF	29-Jul-04	
212	140E110N	8	1	TLS	10-Aug-04	
213	141E112N	2	1	BO	22-Jul-04	omkring 16-17cm
214	141E104-107N	wall cleaning, no vertical control	1	BO	18-Aug-04	
215	141E113N	5	1	KCR	29-Jul-04	
216	141E107N	6	1	TB	17-Aug-04	
217	141E106N	3	1	TIA	5-Aug-04	
218	111N140E	6	1	CF	9-Aug-04	
219	140E110N	9	1	TLS	10-Aug-04	
220	111N141E	7	1	CF	29-Jul-04	
221	141E112N	4	1	BO	27-Jul-04	
222	111N141E	4	1	CF	30-Jul-04	west wall
223	140E113N	3	1	KCR	4-Aug-04	
224	141E110N	1	1		16-Jul-04	
225	140E114N	4	1	LRA	2-Aug-04	
226	141E110N	7	1		28-Jul-05	
227	140E108N	6b	1	CF	21-Jul-05	bottom, X511
228	133E112N		2	CF	4-Aug-05	oyster, X551

229	140E112N	5	1	BO	12-Aug-05	
230	132E115N	sand above moraine	2		9-Aug-05	X599
231	141E109N	6f	1	LRA	19-Jul-05	X464
232	112N132E	oysters below "moraine"	2	CF	9-Aug-05	X601
233	108N140E	6b	1	CF	18-Jul-05	X418
234	113/133	oyster and crushed shell	2	CF	8-Aug-05	X587
235	140E109N	6f	1	KCR	18-Jul-05	X437
236	141.79E109.74N	5		LRA	14-Jul-05	X364, 4.06MOH
237	113/133	oyster and crushed shell	2	CF	8-Aug-05	X588
238	141E108N	6d		TLS	18-Jul-05	X414
239	141E108N	6c		TLS	19-Jul-05	X455
240	141.73E109.84N	5		LRA	14-Jul-05	X365,4.06MOH
241	140E109N	6f	1	KCR	19-Jul-05	X459
242	141E109N	7	1	LRA	21-Jul-05	X504
243	141E112N	6	1	BO	30-Jul-05	
244	141E110N	2	1	TLS	16-Jul-05	
245	141E110N	5	1		27-Jul-05	feature A8
246	141E108N	6d		TLS	18-Jul-05	X430
247	141E109N	5	1	LRA	15-Jul-05	X384
248		under A33		JN	26-Jul-05	X536
249	113/133	crushed shell above oyster	2	CF	4-Aug-05	X568
250	141E109N	5	1	LRA	15-Jul-05	X386
251	140E108N	4	1	CF	13-Jul-05	X341
252	141E108N	7b		TLS	21-Jul-05	X516
253	140E109N	6f	1	KCR	20-Jul-05	X478
254	141E109N	7	1	LRA	21-Jul-05	X512
255	141.50E109.62N	5		LRA	14-Jul-05	X355, 4.00MOH
256	113N133E	crushed shell above oyster	2	CF	4-Aug-05	X570
257	141E111N	5		CF	28-Jul-05	SW quarter, top of midden

258	141E108N	6c		TLS	18-Jul-05	X443
259	140E111N	8	1	CF	10-Aug-05	
260	140E112N	2	1	BO	4-Aug-04	
261	140E113N	4b	1	KCR	5-Aug-04	
262	111N141E	8	1	CF	30-Jul-04	
263	111N/141E	10	1	CF	2-Aug-04	
264	141E107N	4	1	TB	12-Aug-05	
265	133E115N	brown sandy shell/brown tacky	2		2-Aug-05	X541
266			1	KCR	1-Aug-05	FeaA35
267	141E112N	7	1	BO	30-Jul-05	
268		south wall and floor, no vertical control	1		11-Aug-04	
269	141E114N	4	1	LRA	23-Jul-04	
270	133.26E/118.20N	dyregang I skallag		JN	11-Jul-05	skulderblad, KOTE 4.44, X322
271	108N140E	6b	1	CF	19-Jul-05	X456
272	141E109N	5	1	LRA	14-Jul-05	X368, with ceramic
273	140E109N	5	1	KCR	14-Jul-05	X366
274	113N133E	crushed shell above oyster	2	CF	5-Aug-05	X573
275	141E108N	6c		TLS	18-Jul-05	X431
276	140E108N	4	1	CF	14-Jul-05	X344
277	141E109N	5	1	LRA	15-Jul-05	X380
278	117.35N132.90E			MPJ	14-Jul-05	X402, +4.45
279	111N141E	4	1	CF	29-Jun-04	
280	114N133E	brown crushed shell	2	LRA	4-Aug-05	X563
281	109N141E	6f	1	LRA	18-Aug-05	X422
282	114.86N132.5E	top of light sand below midden		LRA	4-Aug-05	X558
283	112N132E	sand below moraine #2	2		july/aug 05	X604
284	109N141E	6e	1	LRA	18-Jul-05	X442
285	141.69E109.64N	5		LRA	14-Jul-05	X354, 4.04MOH
286	140E108N	8 top	1	CF	22-Jul-05	X527

287	109N141E	6e	1	LRA	18-Jul-05	X439
288	141.29E/109.35N	3		LRA	12-Jul-05	X323, 3.99MOH
289	140E/109N	6f	1	KCR	19-Jul-05	X454
290	141E108N	7		TLS	20-Jul-05	X486
291	133E112N	oysters below "moraine"	2	CF	3-Aug-05	X550
292	141E108N	7	1	TLS	21-Jul-05	X508
293	132E112N	oyster	2	CF	4-Aug-05	X555
294	141E108N	6	1	TLS	15-Jul-05	X406
295	109N141E	7	1	LRA	21-Jul-05	X505
296	141E108N	6d		TLS	18-Jul-05	X445
297	141E108N	6c		TLS	15-Jul-05	X388
298	141.88/109.91	5		LRA	14-Jul-05	X349, 4.08MOH
299	140E108N	8	1	CF	21-Jul-05	X522
300	140E109N	6f	1	KCR	20-Jul-05	X479
301	140E109N	6f	1	KCR	19-Jul-05	X452
302	109.62N141.57E	6		LRA	15-Jul-05	X399, 3.91
303	141E	mottled sand under midden	1	CF	2-Aug-05	X548
304	141.82E109.91N	5		LRA	14-Jul-05	X351, 4.07MOH
305	113N133E	oyster	2	CF	8-Aug-05	X583
306	112N132E	shell below "moraine"	2	CF	9-Aug-05	X602
307	140E109N	6f	1	KCR	19-Jul-05	X451
308	140E109N	6f	1	KCR	19-Jul-05	X458
309	140E/108N	6c	1	CF	15-Jul-05	X391
310	109N141E	6e	1	LRA	18-Aug-05	X423
311	109N141E	6e	1	LRA	18-Aug-05	X420
312	140E108N	7	1	CF	20-Jul-05	X496
313	113N133E	brown crushed shell	2	LRA	4-Aug-05	X560
314	140E108N	6c	1	CF	19-Jul-05	X476
315	109N141E	8	1	LRA	20-Jul-05	X490

316	113N133E	crushed shell above oyster	2	CF	4-Aug-05	X572
317	109.05N140.2N	top of crushed shell		KCR	8-Jul-05	X317, 3.95 MOH
318	141E109N	5	1	LRA	15-Jul-05	X377
319	109N141E	8	1	LRA	20-Jul-05	X491
320	109.09N/141.81E	6e		LRA	15-Jul-05	X396, 3.86MOH
321	108N140E	6b	1	CF	19-Jul-05	X462, bottom
322	132E112N	2	2	PN	21-Jul-05	X520
323	141E109N	6f	1	LRA	19-Jul-05	X466
324	141E108N	6c		TLS	15-Jul-05	X382
325	141.75E/109.49N	5		LRA	14-Jul-05	X362, 4.01MOH
326	140E108N	6a1	1	CF	15-Jul-05	X407
327	109N141E	6e	1	LRA	18-Aug-05	X425
328	140E109N	6f	1	KCR	19-Jul-05	X453
329	112/132	brown crushed shell	2	CF	8-Aug-05	X580
330	141.64E109.83N	5		LRA	14-Jul-05	X352, 4.06MOH
331	109N141E	6e	1	LRA	18-Jul-05	X438
332	113/133	brown crushed shell	2	CF	8-Aug-05	X586
333	141E108N	6d		TLS	18-Jul-05	X415
334	140E109N	5	1	KCR	14-Jul-05	X357
335	141.85E109.61N	5		LRA	14-Jul-05	X363, 4.06MOH
336	109.47N141.8E	6e		LRA	15-Jul-05	X397, 3.90MOH
337	132E113N	brown crushed shell	2		5-Aug-05	X577
338	141E108N	6d		TLS	18-Jul-05	X409
339	113/132	oyster/brown dish crushed shell	2	CF	8-Aug-05	X579
340	140N108N	4	1	CF	14-Jul-05	near X344, bottom
341	141E108N	8		TLS	21-Jul-05	X521
342	141E109N	6f	1	LRA	18-Jul-05	X448
343	141E108N	7		TLS	20-Jul-05	X498
344	141E108N	7		TLS	20-Jul-05	X499

345	140E109N	7	1	KCR	20-Jul-05	X487
346	113/133	oyster/brown dish crushed shell	2	CF	8-Aug-05	X581
347	141E109N	6f	1	LRA	19-Jul-05	X473
348	140E109N	6f	1	KCR	19-Jul-05	X463
349	141E108N	5		TLS	14-Jul-05	X361
350	109N141E	6e	1	LRA	18-Aug-05	X421
351	141E109N	6f	1	LRA	18-Jul-05	X447
352	141E108N	6c		TLS	15-Jul-05	X387
353	141.26E109.27N	5		LRA	14-Jul-05	X370, 3.90MOH
354	141E/106N	1b-1d	1	TB	8-Aug-04	walls tidy up
355	108N140E	6a1	1	CF	18-Jul-05	X428
356	140E109N	5b	1	KCR	18-Jul-05	X419
357	141E108N	7		TLS	20-Jul-05	X483
358	133E113N	crushed shell above oysters			4-Aug-05	X569
359	109.56N/141.33E	6		LRA	15-Jul-05	X400, 3.85MOH
360	141E109N	8	1	LRA	21-Jul-05	X518
361	109N141E	6e	1	LRA	18-Jul-05	X440
362	140.7/108.7	5	1	CF	14-Jul-05	X359
363	141E108N	6c		TLS	15-Jul-05	X392
364	141E109N	5	1	LRA	15-Jul-05	X378
365	140.35/108.30	5	1	CF	14-Jul-05	X360
366	141E109N	5	1	LRA	15-Jul-05	X379
367	140E109N	6f	1	KCR	20-Jul-05	X480
368	114.54N/132.59E	top of light sand below midden	1	LRA	4-Aug-05	X557
369	108N140E	6b	1	CF	19-Jul-05	X481, bottom
370	109N141E	6f	1	LRA	19-Jul-05	X460
371	108N140E	6b	1	CF	18-Jul-05	X432
372	140E108N	6b	1	CF	21-Jul-05	X510, bottom
373	113N133E	transisting crush shell to sand below midden	2	CF	8-Aug-05	X592

374	141E108N	7		TLS	21-Jul-05	X506
375	108N140E	7	1	CF	20-Jul-05	X492
376	133/113	brown crushed shell	2	CF	8-Aug-05	X582
377	141.43E/109.04N	5		LRA	14-Jul-05	X369, 3.90 MOH
378	140E109N	5b	1	KCR	18-Jul-05	X426
379	141E108N	6d	1	TLS	18-Jul-05	X429
380	117.79N132.54E			MPJ	25-Jul-05	X531, +4.44
381	141E108N	7		TLS	20-Jul-05	X502
382	141E108N	7		TLS	20-Jul-05	X500
383	141E109N	6f	1	LRA	19-Jul-05	X471
384	140E109N	5	1	KCR	14-Jul-05	X356
385	140E108N	4 bottom	1	CF	14-Jul-05	X342
386	112/132	below oyster	2	CF	4-Aug-05	X566
387	141E109N	5	1	LRA	15-Jul-05	X374
388	141.52E/109.74N	5		LRA	14-Jul-05	X353, 4.02MOH
389	141E109N	5	1	LRA	15-Jul-05	X376
390	141E108N	7		TLS	20-Jul-05	X503
391	141E108N	6d		TLS	18-Jul-05	X410
392	141E108N	5		TLS	14-Jul-05	X367
393	133E115N	brown tacky oyster layer	2		2-Aug-05	X542
394	140E108N	5	1	CF	14-Jul-05	X358
395	141.78E109.74N	5		LRA	14-Jul-05	X372, 4.01MOH
396	141.85E/109.64N	5		LRA	14-Jul-05	X371, 4.02MOH
397	141E109N	6(?)	1	LRA	15-Jul-05	X401
398	108N140E	66(?)	1	CF	18-Jul-05	X433
399	140E109N	6f	1	KCR	18-Jul-05	X436
400	113N132E	sand below midden or sand above moraine #1	2	CF	8-Aug-05	X589
401	140E109N	6f	1	KCR	19-Jul-05	X449
402	140E109N	8	1	KCR	21-Jul-05	X513

403	140E108N	8	1	CF	22-Jul-05	X530
404	141E109N	5	1	LRA	15-Jul-05	X385
405	141.77E/109.77N	5		LRA	12-Jul-05	X343, 4.05MOH
406	141E109N	5	1	LRA	15-Jul-05	X375
407	108N140E	7	1	CF	20-Jul-05	X484
408	108N140E	6a1	1	CF	18-Jul-05	X427
409	141E109N	6f	1	LRA	19-Jul-05	X470
410	140E109N	6f	1	KCR	19-Jul-05	X450
411	108N140E	7	1	CF	20-Jul-05	X493
412	141E108N	6c		TLS	15-Jul-05	X394
413	140E109N	6f	1	KCR	18-Jul-05	X434
414	141E109N	6F	1	LRA	19-Jul-05	X465
415	112N132E	shell below "moraine"	2	CF	9-Aug-05	X600
416	141E108N	6c		TLS	15-Jul-05	X383
417	113N132E	sand above moraine #1	2	CF	8-Aug-05	X589
418	108N140E	6a "2"	1	CF	20-Jul-05	X494
419	140E109N	7	1	KCR	20-Jul-05	X488
420	140E108N	6a1	1	CF	15-Jul-05	X395
421	140E109N	6f	1	KCR	18-Jul-05	X435
422	141E108N	7		TLS	20-Jul-05	X497
423	140E108N	6c	1	CF	15-Jul-05	X390
424	114N133E	brown crushed shell	2	LRA	4-Aug-05	X564
425	109N141E	6e	1	LRA	18-Aug-05	X424
426	141E/110N	7	1	TLS	28-Jul-04	
427	141E/112N	3	1	BO	23-Jul-04	
428	141E/116N					Plan 2, NW 410/425, 2004
429	111N/146E	13B	1	CF	5-Aug-04	A15
430	140E/114N	6	1	LRA	4/8/2004	
431	141E120N	kulturlag	1	MJ	19-Aug-04	

432	141E114N	6	1	LRA	29-Jul-04	
433	111N/140E	3c	1	CF	5-Aug-05	A16
434	141E107N	3	1	TB	11-Aug-04	
435	141E116N				26-Jun-05	NW437, plan 2
436	141E112N	9	1	BO	3-Aug-04	
437	115N141E	5	1	LRA	10-Aug-04	
438	141E106N	5	1	TB	10-Aug-04	
439	140E/107N	3	1	TB	27-Jul-04	
440	140E112N	3	1	BO	10-Aug-04	
441	141E107N	5	1	TB	13-Aug-04	
442	116N140E	1	1	LRA	12-Aug-04	
443	140E115N	4	1	LRA	10-Aug-04	
444	140E113N	7	1	KCR	12-Aug-04	
445	141E116N			PP	26-Jun-05	NV425/422, Plan 3
446	104E104N	groft grus på skallag		JN	23-Jul-04	
447	114N140E	5	1	LRA	3-Aug-04	
448	140E116N	2	1	LRA	17-Aug-04	
601	141E110N	6	1		27-Jul-04	X87
602	140E110N	7	1	TLS	9-Aug-04	X193
603	141E111N	3	1	CF	22-Jul-04	X37
604	111N140E	5	1	cf		x177
605	140E110N	6	1			x181
606	149.94E113.44N	4	1	kcr		x57
607	141E112N	2	1	bo		x32
608	114.27N141.14E	4		lra		x128
609	114.66N141.5E	6		lra		x81
610	141E110N	3	1			x21
611	141.74E114.23N	7	1	kcr		x124
612	141E107N	5	1	tb		x251

613	140E110N	6	1	tls	x180
614	141E110N	4	1		x53
615	141E112N	3-4 transitional	1	bo	x82
616	114.22N140.24E	4/A14		lra	x137
617	114.25N140.65E	5/A15		lra	x139
618	140E112N	5	1	bo	x250
619	141E110N	7	1		x91
620	141E111N	3	1	cf	x39
621	141E112N	3	1	bo	x46
622	141E107N	5	1	tia	x264
623	141E110N	3	1		x20
624	141E110N	5	1		x77
625	111N140E	8	1	cf	x223
626	111N141E	3	1	cf	x38
627	140.46E113.49N	6		kcr	x232
628	141E110N	5	1		x73
629	141.90E114.08N	4	1	lra	x31
630	140.54E113.50N	5	1	kcr	x220, z=3.985
631	140E110N	6	1		x188
632	141.55E114.16N	4	1	lra	x42
633	140E110N	6	1		x186
634	116.70N140.70E	2		lra	x260
635	141E112N	transitional 4-5	1	bo	x112
636	141E107N	3	1	tb	x241
637	141E107N	5	1	tb	x257
638	111N140E	8	1	cf	x225
639	141E107N	6	1	tb	x275
640	141E107N	5	1	t b	x254
641	141E110N	4	1		X542

642	140E110N	5			x172
643	141E107N	6	1	tb	x279
644	141E110N	5	1		x78
645	111N140E	7		cf	x204
646	140E111N	7	1		x212
647	140E110N	7	1		x210
648	140E106N	2	1	tb	x126
649	111N140E	7	1	cf	x211
650	140.50E113.38N	5	1	kcr	x226
651	111N141E	4	1	cf	x80
652	140E110N	7	1		x200
653	141E112N	3	1	bo	x65
654	141E110N	2	1	tls	x14
655	140.16E113.67N	5	1	kcr	x179
656	140.79E113.85N	7	1	kcr	x242
657	141E110N	4	1		x51
658	141E111N	3	1	cf	x29
659	141.69E113.23N	4	1	kcr	x56
660	140E112N	2	1	bo	x149
661	111N140E	5	1	cf	x175
662	141E110N	3	1		x30
663	114.28N141.10E	5		lra	x62
664	140E112N	8	1	bo	x269
665	140E110N	7	1		x198
666	140E110N	5	1		x168
667	111N141E	5		cf	x100
668	141E110N	3	1		x33
669	111N140E	1(2)	1	cf	
670	111N141E	3	1	cf	x45

671	141E112N	4	1	bo	x102
672	141E110N	6	1		x88
673	141E110N	5	1		x72
674	141E112N	7	1	bo	x48
675	141E110N	3	1		x22
676	140E112N	3	1	bo	x258
677	141.25E113.31N	5			x109
678	141E110N	2	1		x16
679	140.52E113.27	4	1	kcr	x158
680	141E110N	8	1		x93
681	141.48E113.00N	4	1	kcr	x58
682	111N141E	3	1	cf	x49
683	115.52N140.20E	4		lra	x213
684	112N141E	4	1	cf	x64
685	141E111N	3	1	cf	x36
686	141E115N	6		lra	x155
687	114.28N140.65E	5/A14		lra	x138
688	111N140E	4	1	cf	x174
689	140E111N	7	1		x208
690	114.05N141.20E	5		lra	x70
691	114.44N140.22E	5/A14		lra	x143
692	114.46N140.12E	5/A14		lra	x141
693	111N140E	7	1	cf	x194
694	111N140E	6	1	cf	x191
695	140E112N	9	1	bo	x278
696	111N140E	5/A21	1	cf	
697	140E110N	6	1		x187
698	140E110N	7	1		x207
699	140E112N	7	1	bo	x265

700	140E110N	5	1		x171
701	141E110N	3	1		x24
702	141E112N	2	1	bo	x35
703	141E110N	4	1		x52
704	111N141E	10	1	cf	x134
705	140E110N	7	1		x199
706	140E110N	5	1		x173
707	140E110N	6	1		x189
708	141E110N	5	1		x79
709	141.4E114.08N	5		lra	x50
710	140.72E113.58N	5	1	kcr	x233
711	141E112N	3	1	bo	x59
712	111N140E	5	1	cf	x176
713	141.80E113.13N	4	1	kcr	x41
714	141E110N	4	1		x44
715	141.68E113.53N	5	1		x61
716	111N141E	6	1	cf	x113
717	115.05N141.08E	4		lra	x230
718	141E110N	5	1		x67
719	111N140E	8	1	cf	x224
720	141E110N	5	1	bo	x74
721	141E112N	4	1	bo	x99
722	141E112N	7	1	bo	x94
723	140E110N	7	1		x197
724	140E110N	3	1		x196
725	140E107N	transitional 4-5	1	tb	x89
726	114.34N140.58E	5/A14		lra	x140
727	141E110N	6	1		x84
728	140E110N	7	1		x209

Appendix VI: Trustrup Bag Proveniences

Bag #	Square	Lag	Other	Date	Name
1	105E/110N	Plozelag		7/17/2002	JN
2	94E/100N	Mixed marl/cultural horizon		7/29/2002	
3	97E/101N	Mixed marl/cultural horizon		8/6/2002	
4	100E/101N	culture layer		8/7/2002	TLS
5	103E/100N	culture layer		7/18/2002	KR
6	101E/103N	torv		7/31/2002	JN
7	94E/100N	mixed marl/cultural deposit	screened	7/19/2002	
8	86E/100N	mixed marl		7/23/2002	TDP
9	100E/100N	culture layer		7/22/2002	
10	90E/100N	culture layer	east 1/4 of unit	7/18/2002	TDP
11	87E/100N	culture layer		7/29/2002	TDP
12	81E/116N				
13	98E/100N	cultural layer	screened	7/23/2002	
14	88E/100N	mixed marl		7/29/2002	TDP
15	98E/100N	mixed marl above culture layer		7/19/2002	
16	87E/100N	mixed marl		7/29/2002	TDP
17	98E/101N	mixed marl	kk2	8/9/2002	TLS
18	97E/100N	marl (mixed)		7/17/2002	TDP
19	101E/102N	culture layer		7/31/2002	TLS
20	100E/100N	mixed marl		7/22/2002	TLS
21	89E/100N	mixed marl below culture layer		8/2/2002	
22	99E/100N	mixed marl below culture layer		7/29/2002	
23	91E/100N	peat + cultural layer		7/30/2002	AR
24	100E/101N	culture layer		8/6/2002	TLS
25	91E/116N	forest		8/7/2002	
26	98E/101N	peat layer		8/12/2002	TLS
27	99E/100N	plowzone		7/19/2002	
28	98E/101N	mixed marl	kk2	8/8/2002	TLS
29	97E/100E	mixed marl		7/17/2002	TDP

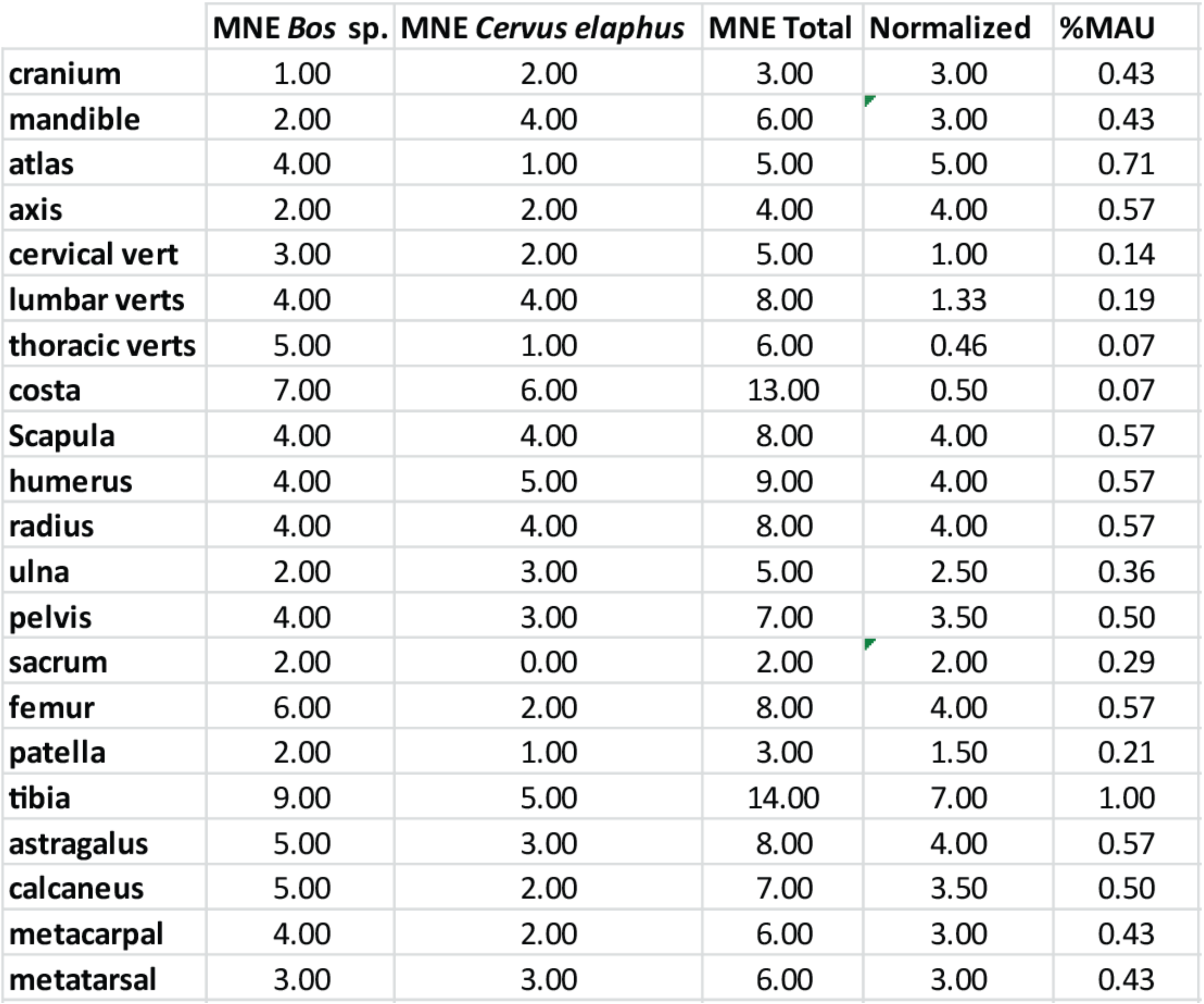
30	98E/106N	culture layer		8/9/2002	JN
31	99E/101N	peat layer		8/6/2002	TDP
32	100N/94E	mixed marl		7/2/2002?	
33	101E/105N	culture layer		7/19/2002	JN
34	98E/101N	mixed marl	kk1	8/8/2002	TLS
35	98E/100N	culture layer		7/22/2002	
36	101E/101N	peat layer		7/24/2002	TLS
37	97E/100N	peat disturbance		7/16/2002	TDP
38	95E/100N	mixed marl		7/17/2002	AR
39	86E/100N	culture layer		722/2002	TDP
40	101E/107N	culture layer		7/24/2002	JN
41	85E/100N	mixed marl		8/6/2002	AR
42	98E/101N	mixed marl	kk2	8/12/2002	TLS
43	85E/100N	culture layer		8/6/2002	AR
44	101E/101N	culture layer		7/29/2002	TLS
45	99E/106N	torv		8/8/2002	JN
46	98E/101N	mixed marl	kk1	8/8/2002	TLS
47	94E/100N	mixed marl and culture layer		7/22/2002	AR
48	98E/101N	mixed marl	kk2	8/13/2002	TLS
49	95E/100N	culture layer		7/17/2002	AR
50	97E/101N	mixed marl		8/7/2002	
51	97E/100N	top of marl + culture layer		7/17/2002	TDP
52	101E/101N	mixed marl layer		7/24/2002	TLS
53	98E/101N	peat layer		8/9/2002	TLS
54	100E/100N	culture layer		7/23/2002	TLS
55	78E/100N	plowzone		7/30/2002	
56	100E/106N	culture layer		8/7/2002	JN
57	102E/100N	culture layer		7/18/2002	TLS
58	99E/101N	cultural layer		8/7/2002	TDP
59	80E/100N	mixed marl below plowzone		7/29/2002	
60	98E/101N	peat layer	east 1/2-top	8/8/2002	TLS
61	97E/106N	peat layer		8/13/2002	JN
62	TP3	max	contains C14 sample	8/5/2002	KR
63	100E/100N	peat layer		7/18/2002	TLS

64	89E/100N	peat layer below plowzone		8/2/2002	
65	91E/100N	PZ-Peat		7/29/2002	AR
66	101E/101N	culture layer	1 of 2	7/29/2002	TLS
67	100E/106N	torv		8/6/2002	JN
68	87E/100N	PZ + ditch backfill		7/23/2002	TDP
69	100E/100N	peat layer		7/18/2002	TLS
70	80E/100N	mixed marl	lower		
71	100N/87E	culture lag		7/29/2002	
72	99E/101N	plowzone		8/6/2002	TDP
73	88E/100N	plowzone		7/29/2002	TDP
74	100N/91E	MM/CL	burned bone		
75	105E/110N	plowzone		7/17/2002	JN
76	100E/100N	peat layer	screened	7/19/2002	TLS
77	99E/100N	peat layer		7/23/2002	
78	91E/100N	mixed marl + c layer		7/31/2002	AR
79	93E/100N	cultural horizon + peat		7/27/2002	AR
80	100E/101N	peat layer		8/6/2002	TLS
81	86E/100N	culture lag		7/23/2002	TDP
82	91E/100N	peat + culture layer		7/30/2002	
83	102E/100N	culture layer		7/17/2002	TLS
84	85E/100N	culture layer		8/6/2002	AR
85	98E/106N	torv		8/8/2002	JN
86	98E/101N	plowzone		8/8/2002	TLS
87	99E/100N	mixed marl		7/24/2002	KR
88	83E/100N	culture layer	disturbed	8/7/2002	AR
89	99E/101N	peat layer	2 of 2	8/7/2002	TDP
90	98E/100N	plowzone		7/18/2002	KR
91	100E/101N	peat layer		8/2/2002	TLS
92	93E/100N	cultural horizon + peat		7/27/2002	AR
93	104E/100N	plowzone		7/16/2002	KCR
94	95E/100N	mixed marl		7/17/2002	AR
95	97E/106N	culture layer		8/13/2002	JN
96	104E/100N	peat above culture layer		7/16/2002	
97	86E/100N	plowzone		7/18/2002	TDP

98	94E/100N	mixed marl/cultural level		7/18/2002	AR
99	98E/101N	peat layer		8/9/2002	TLS
100	92E/100N	plowzone		7/23/2002	AR
101	87E/100N	peat layer			TDP
102	101E/102N	peat layer		7/30/2002	TLS
103	102E/100N	peat layer		7/17/2002	TLS
104	85E/100N	plowzone + ditch spoil		8/6/2002	AR
105	100E/100N	mixed marl		7/19/2002	TLS
106	99E/106N	plowzone		8/7/2002	JN
107	99E/100N	cultural layer		7/24/2002	KR
108	86E/100N	peat layer		7/27/2002	
109	98E/100N	mixed marl		7/22/2002	
110	91E/116N	forest turf		8/7/2002	
111	99E/101N	upper cultural layer	S.wall	8/6/2002	TDP
112	94E/100N	cultural layer - marl contact		7/18/2002	AR
113	94E/100N	culture layer/marl contact		7/18/2002	AR
114	95E/100N	cultural lag	bone	7/16/2002	AR
115	102E/100N	culture	gyttja layer	7/17/2002	TLS
116	102E/100N	culture layer		7/17/2002	
117	94E/100N	mixed marl/cultural deposit		7/19/2002	
118	98E/100N	peat layer	E1/2 of unit	7/22/2002	
119	101E/106N	torv		7/23/2002	JN
120	89E/100N	culture layer above mix marl		8/2/2002	
121	104E/100N	culture layer		7/17/2002	KR
122	91E/100N	cultural horizon		7/31/2002	AR
123	99E/106N	culture layer		8/8/2002	JN
124	80E/100N	plowzone		7/29/2002	
125	101E/102N	culture layer	all contents ceramic	7/31/2002	TLS
126	89E/100N	pz + disturbance		7/31/2002	
127	99E/100N	plowzone		7/23/2002	KR
128	83E/100N	plowzone		8/7/2002	AR
129	104E/100N	cultural level		7/16/2002	KCR
130	104E/100N	culture layer	drilled?	7/17/2002	KR
131	103E/100N	pz		7/17/2002	

132	97E/101N	plowzone		8/2/2002	
133	101E/103N	kulturlag		8/2/2002	JN
134	97E/101N	culture layer beneath mixed marl		8/6/2002	
135	93E/100N	mixed marl		7/24/2002	AR
136	100E/100N	mixed marl		7/22/2002	
137	89E/100N	peat layer		7/31/2002	
138	93E/100N	plowzone		7/22/2002	AR
139	104E/100N	peat below plowzone		7/16/2002	KCR
140	102E/100N	plowzone		7/16/2002	TLS
141	101E/106N	culture layer		7/29/2002	JN
142	101E/102N	culture layer			TLS
143	97E/101N	peat layer above mixed marl		8/6/2002	
144	104E/100N	plowzone	all contents metal	7/16/2002	KCR
145	88E/100N	culture lag			
146	94E/100E	peat above midden		7/18/2002	AR
147	98E/100N	peat layer	east 1/2	7/19/2002	
148	92E/100N	mixed marl/culture layer	adjacent to stone feature	7/29/2002	AR
149	103E/100N	peat below plowzone		7/17/2002	
150	102E/100N	culture layer		7/17/2002	TLS
151	92E/100N	marl contact + pit fill		7/24/2002	AR
152	88E/100N	peat		7/29/2002	TDP
153	101E/105N	culture layer		7/19/2002	JN
154	100N/102E	culture lag		7/18/2002	TLS
155	100E/100N	culture layer		7/23/2002	
156	80E/100N	mixed marl below plowzone		7/16/2002	
157	81E/116N	forest turf		8/8/2002	

Appendix VII: Havnø Large Mammal MAU Calculations

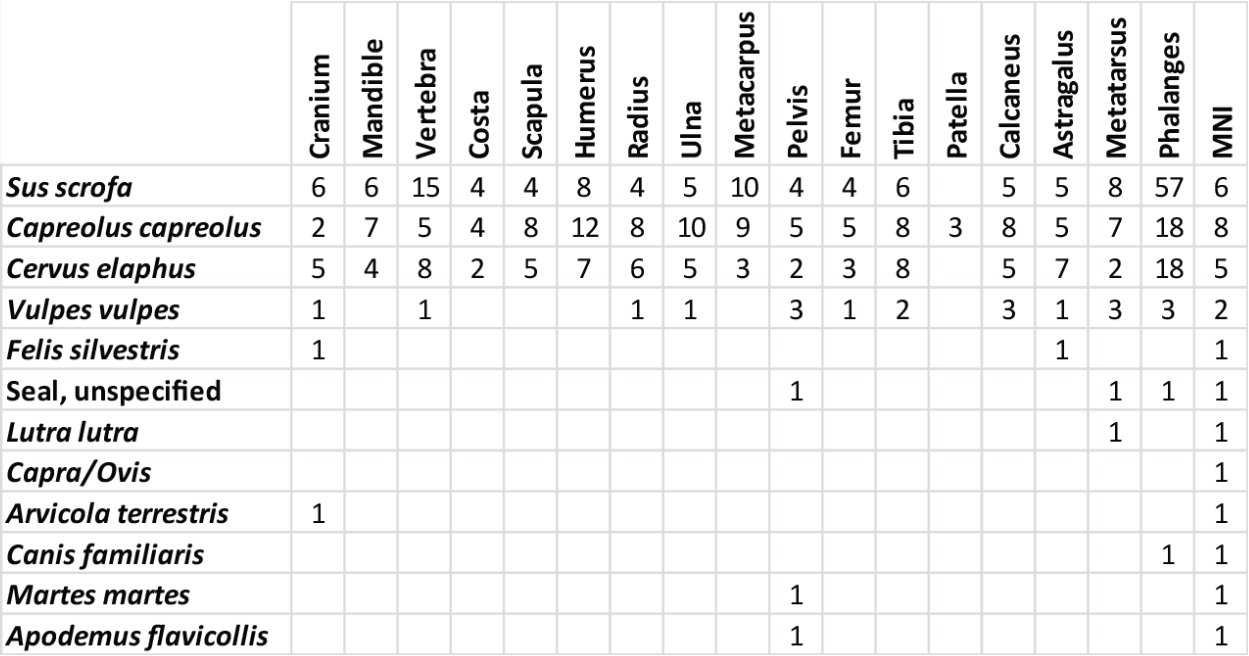


	MNE *Bos* sp.	MNE *Cervus elaphus*	MNE Total	Normalized	%MAU
cranium	1.00	2.00	3.00	3.00	0.43
mandible	2.00	4.00	6.00	3.00	0.43
atlas	4.00	1.00	5.00	5.00	0.71
axis	2.00	2.00	4.00	4.00	0.57
cervical vert	3.00	2.00	5.00	1.00	0.14
lumbar verts	4.00	4.00	8.00	1.33	0.19
thoracic verts	5.00	1.00	6.00	0.46	0.07
costa	7.00	6.00	13.00	0.50	0.07
Scapula	4.00	4.00	8.00	4.00	0.57
humerus	4.00	5.00	9.00	4.00	0.57
radius	4.00	4.00	8.00	4.00	0.57
ulna	2.00	3.00	5.00	2.50	0.36
pelvis	4.00	3.00	7.00	3.50	0.50
sacrum	2.00	0.00	2.00	2.00	0.29
femur	6.00	2.00	8.00	4.00	0.57
patella	2.00	1.00	3.00	1.50	0.21
tibia	9.00	5.00	14.00	7.00	1.00
astragalus	5.00	3.00	8.00	4.00	0.57
calcaneus	5.00	2.00	7.00	3.50	0.50
metacarpal	4.00	2.00	6.00	3.00	0.43
metatarsal	3.00	3.00	6.00	3.00	0.43

Appendix VIII: MNE Data

	Cranium	**Mandible**	**Vertebra**	**Costa**	**Scapula**	**Humerus**	**Radius**	**Ulna**	**Metacarpus**	**Pelvis**	**Femur**	**Tibia**	**Patella**	**Calcaneus**	**Astragalus**	**Metatarsus**	**Phalanges**	**MNI**
Capreolus capreolus	10	33	66	31	19	30	28	26	14	20	16	30	11	35	10	22	134	19
Martes martes	1	10	8		1	1	5	2	4	7	1	1				1	4	5
Sus scrofa	2	6	8	1	3	2		2	7	1				4	2	1	6	4
Canis familiaris	1	2	3	7		3	3	6	9	4	3	5		2	2	7	10	4
Erinaceus europaeus	1	5				1	1	2										4
Cervus elaphus	1	2	9	2	3	2	2		3	1	2	4	1	3	3	2	7	3
Vulpes vulpes	1	3	7		2		3	3			2	1		1			7	2
Castor fiber			3	1	1	2	1					1		1	1	1	3	2
Sciurus vulgaris		2																2
Lutra lutra		2	1			1											1	2
Apodemus flavicollis		2									2							2
Phocoena phocoena	2		7															1
Felis silvestris							1					1						1
Clethrionomys glareolus		1																1
Arvicola terrestris		1																1
Phocidae	1	1	6	5	2	4	9	5	7	4	1			1	1	1	44	5

Asnæs Havnemark MNE Data



	Cranium	Mandible	Vertebra	Costa	Scapula	Humerus	Radius	Ulna	Metacarpus	Pelvis	Femur	Tibia	Patella	Calcaneus	Astragalus	Metatarsus	Phalanges	MNI
Sus scrofa	6	6	15	4	4	8	4	5	10	4	4	6		5	5	8	57	6
Capreolus capreolus	2	7	5	4	8	12	8	10	9	5	5	8	3	8	5	7	18	8
Cervus elaphus	5	4	8	2	5	7	6	5	3	2	3	8		5	7	2	18	5
Vulpes vulpes	1		1				1	1		3	1	2		3	1	3	3	2
Felis silvestris	1														1			1
Seal, unspecified										1						1	1	1
Lutra lutra																1		1
Capra/Ovis																		1
Arvicola terrestris	1																	1
Canis familiaris																	1	1
Martes martes										1								1
Apodemus flavicollis										1								1

Fårevejle MNE Data

	Cranium	Mandible	Vertebra	Costa	Sternum	Scapula	Humerus	Radius	Ulna	Metacarpus	Pelvis	Femur	Tibia	Patella	Calcaneus	Astragalus	Metatarsus	Phalanges	MNI
Cervus elaphus	5	2	2			6	11	4	7	3	9	2	8	1	10	20	3	13	9
Capreolus capreolus	7	2	2			6	14	8	2	3	6	1	6	3	19	24	7	32	14
Sus scrofa	1	1	1			3	6	2	2	4	3		2		7	8	1	19	6
Canis familiaris		2					2	1	2	1			3		1	1	4	6	2
Castor fiber	1								2				1			1	1	1	1
Equus caballus																			1
Lutra lutra		1						1											1
Capra/Ovis																			1
Felis silvestris							1											1	1
Martes martes		1																	1
Vulpes vulpes							1												1
Halichoerus grypus																			1
Bos taurus								1											1

Trustrup MNE Data

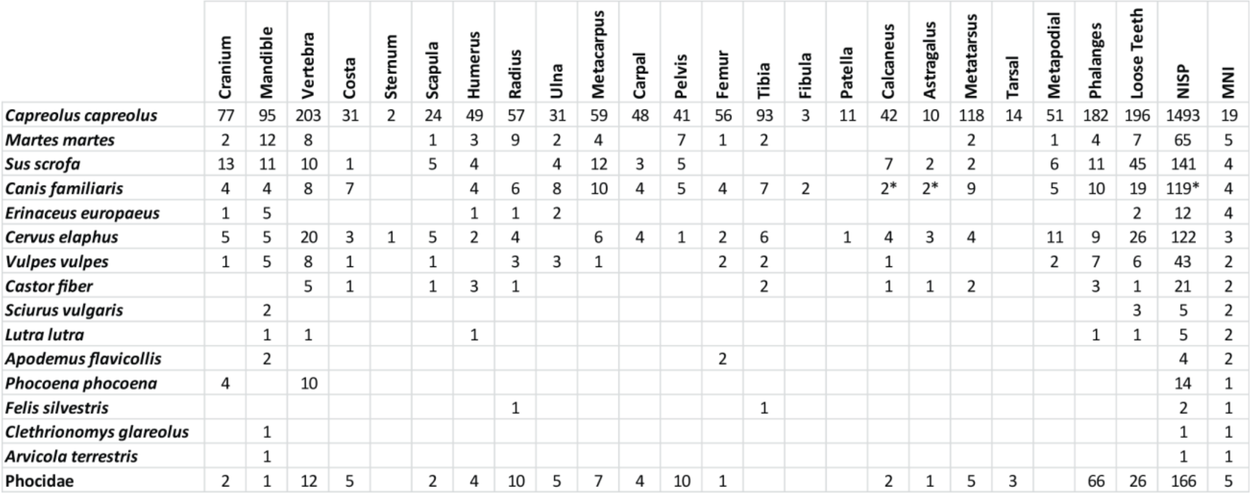
	Cranium	Mandible	Vertebra	Costa	Sternum	Scapula	Humerus	Radius	Ulna	Metacarpus	Pelvis	Femur	Tibia	Patella	Calcaneus	Astragalus	Metatarsus	Phalanges	MNI
Sus scrofa	4	1	8	4		11	6	9	10	26	7	2	8	2	7	8	16	73	8
***Bos* sp.**	1	2	18	7		4	4	4	2	4	4	6	9	2	5	5	3	35	7
Cervus elaphus	2	4	10	6		4	5	4	3	2	3	2	5	1	2	2	3	11	3

Havnø MNE Data

Appendix IX: Data From the Literature Used in Comparisons

	Citation	Totals	*Capreolus capreolus*	*Cervus elaphus*	*Sus scrofa*	*Canis familiaris*	*Castor fiber*	*Erinaceus europaeus*	*Felis silvestris*	*Lutra lutra*	*Martes martes*	*Phocoena phocoena*	*Sciruius vulgaris*	Seal	*Vulpes vulpes*	*Bos primigenius*	*Mustela putorius*	*Meles meles*	*Lynx lynx*	*Canis lupus*	*Alces alces*	Possible domesticates	Domesticates
EBK Sites (NISP)																							
Agernæs	Richter and Noe-Nygaard 2003	3981	820	1335	162	264		14	114	28	1149	1		3	81	1	2		5	2			
Aggersund	Møhl 1979	208	4	40	117	18		26		3													
Åkonge	Gotfredsen 1998	2376	456	1659	189			34		10	8		1		19								
Asnæs Havnemark	This work	2208	1493	122	141	119	21	12	2	5	65	14	5	166	43								
Bökebjerg III	Erickson and Magnell 2001	1578	163	1060	190	18	1			1	10		3		5			4		3	120		
Bredasten	Magnell cited in Imperaiale 2011	2222	167	625	1334	28	10			5	8			39	2			2		2			
Dyrholmen	Degerbøl 1942	1595	229	576	542	31	1		13	13	11	3	2	2	4	117		18	4	3	26		
Ertebølle	Enghoff 2011	420	153	131	92	7			6	2	6			4	17	1				1			
Fårevejle	Gron unpublished	1263	435	231	554	1			7	3	1			5	26								
Flynderhage	cited in Enghoff 2011	1705	158	299	527	97			8	6	179	6		115	10	274	1	10	1	4	10		
Hjerk Nor	Hatting et al. 1973	616		122	98	16			196	37	25				14	87	1	8	12				
Lollikhuse	Magnussen 2007	1054	448	443	112	17	3	3	2	4	5	1		16									
Lystrup Enge	Enghoff 2011	1447	178	500	380	2	4	1	3	4	1		1	3	2	314		5	1	1	47		
Norslund	Andersen and Malmros 1966	738	86	171	215	12			6	2	8	1	1	31	8	182		7		3	5		
Ølby Lyng	Møhl 1971	1337	330	646	137	36	4		5	6	6	23		143	1								
Østenkær	Enghoff 2011	2723	536	1420	579	12		1	4	3	17	1	1	130	6	13							
Præstelyng	Noe-Nygaard 1995	1229	778	263	114	19	2	11		25	16		1										
Ringkloster	Richter and Noe-Nygaard 2003	5036	136	1685	1930	69			10	80	772				51	282	5		2	14			
Ronæs Skov	Andersen 2009	506	80	180	165	15			16	6	3	3		34	2	1	1						
Skateholm I	Jonsson 1988	1067	174	182	447	15	12	4	26	30	2		2	136	24			2		9	2		
Skateholm II	Jonsson 1988	1520	703	182	447	6	3	13	20	18	8	2	1	103	5			4			5		
Smakkerup Huse	Price and Gebauer 2005	1783	682	739	279	39	3	6	10	17	3		1	3	1								
Sølager (layer 1)	Skaarup 1973	445	186	42	48	75	3		5	33	9		2	33	9								
Spangkonge	Gotfredsen 2004	1988	349	1544	83		1	9							2								
Trustrup	This work	1230	443	508	198	47	20		2	6	2		1	1	2								
Tybrind Vig	Richter and Noe-Nygaard 2003	1736	142	390	194	58			102	122	658	1		24	1	3	41						
Vængesø III	Enghoff 2011	824	91	25	158	77			14	5	84	6	2	321	28	7	1	5					
Visborg	Enghoff 2011	654	102	203	254	10			9	1	3			29	3	22					18		
Transitional Sites (NISP)																							
Bodal K	Gotfredsen 2003	5672	845	4155		24	89	17	18	127	32			25								340	
Havnø	This work	1187	51	192		58	3		1	5	1			86	2	1					2	666	119
Neustadt	Glykou 2011	3608	242	798		234	24	20	12	68	19	137		1072	6	176	3	7	3	7	54	703	23
Wangels	Heinrich 1999	434	23	65	11	11				1	1			5		13						75	229
Neolithic Sites (NISP)																							
Anneberg	Segerberg 1999	848		1		11	6		2	17	17	2	8	674	3			1			2	46	58
Havnelev	Koch 1998	562		6		2								6									548
Karleby Logården B and C	Sjögren 2003	360		2		2			1				1									173	181
Muldbjerg I	Noe-Nygaard 1995	1086	665	116			179	4		115	2											5	
Skumparberget	Hallgren 1998	550							1		1			1								130	417
Visborg	Enghoff 2011	239	51	80						1	5			2								96	4
Mesolithic Sites (MNI)																							
Åkonge	Gotfredsen 1998	50	12	18	8			4		2	2		1		3								
Asnæs Havnemark	This work	54	19	3	4	4	2	4	1	2	5	1	2	5	2								
Fårevejle	This work	26	8	5	6	1			1	1	1			1	2								
Hjerk Nor	Hatting et al. 1973	48	0	9	9	3				4	6				3	3	1	4	6				
Lollikhuse	Magnussen 2007	55	21	16	5	3	1	1	1	2	1	1		1	2								
Præstelyng	Noe-Nygaard 1995	33	11	7	3	1	1	4		2	3		1										
Smakkerup Huse	Price and Gebauer 2005	57	20	15	8	2	1	3	2	2	1		1	1	1								
Trustrup	This work	38	14	9	6	2	1		1	1	1		1	1	1								
Transitional Sites (MNI)																							
Neustadt	Glykou 2011	118	9	13	14	5	5	3	2	3	4	6		27	1	13	1	1	1	1	3	3	3
Neolithic Sites (MNI)																							
Muldbjerg I	Noe-Nygaard 1995	23	5	2			4	2		3	1											5	

Appendix X: Relative Abundance by Element



	Cranium	Mandible	Vertebra	Costa	Sternum	Scapula	Humerus	Radius	Ulna	Metacarpus	Carpal	Pelvis	Femur	Tibia	Fibula	Patella	Calcaneus	Astragalus	Metatarsus	Tarsal	Metapodial	Phalanges	Loose Teeth	NISP	MNI
Capreolus capreolus	77	95	203	31	2	24	49	57	31	59	48	41	56	93	3	11	42	10	118	14	51	182	196	1493	19
Martes martes	2	12	8			1	3	9	2	4		7	1	2					2		1	4	7	65	5
Sus scrofa	13	11	10	1		5	4		4	12	3	5					7	2	2		6	11	45	141	4
Canis familiaris	4	4	8	7			4	6	8	10	4	5	4	7	2		2*	2*	9		5	10	19	119*	4
Erinaceus europaeus	1	5					1	1	2														2	12	4
Cervus elaphus	5	5	20	3	1	5	2	4		6	4	1	2	6		1	4	3	4		11	9	26	122	3
Vulpes vulpes	1	5	8	1		1		3	3	1			2	2			1				2	7	6	43	2
Castor fiber			5	1		1	3	1						2			1	1	2			3	1	21	2
Sciurus vulgaris		2																					3	5	2
Lutra lutra		1	1				1															1	1	5	2
Apodemus flavicollis		2											2											4	2
Phocoena phocoena	4		10																					14	1
Felis silvestris								1						1										2	1
Clethrionomys glareolus		1																						1	1
Arvicola terrestris		1																						1	1
Phocidae	2	1	12	5		2	4	10	5	7	4	10	1				2	1	5	3		66	26	166	5

Asnæs Havnemark Relative Abundance by Element (NISP)

	Cranium	Mandible	Vertebra	Costa	Sternum	Scapula	Humerus	Radius	Ulna	Metacarpus	Carpal	Pelvis	Femur	Tibia	Fibula	Patella	Calcaneus	Astragalus	Metatarsus	Tarsal	Metapodial	Phalanges	Loose Teeth	Sesamoids	NISP	MNI
Sus scrofa	59	30	31	4		5	14	9	10	12	30	6	10	12			6	5	14	15	38	62	181	1	554	6
Capreolus capreolus	10	20	5	4		8	20	17	10	25	19	9	10	28		3	8	5	32	9	19	42	132		435	8
Cervus elaphus	10	10	15	2		5	16	10	7	6	3	5	5	26	3		6	8	9	2	6	23	54		231	5
Vulpes vulpes	1		1					2	1		1	4	1	2			3	1	3		1	3	2		26	2
Felis silvestris	1										1							1					4		7	1
Seal, unspecified												1							2	1		1			5	1
Lutra lutra																			1				2		3	1
Capra/Ovis																							2		2	1
Arvicola terrestris	1	1																							2	1
Canis familiaris																						1			1	1
Martes martes												1													1	1
Apodemus flavicollis												1													1	1

Fårevejle Relative Abundance by Element (NISP)

	Cranium	Mandible	Vertebra	Costa	Sternum	Scapula	Humerus	Radius	Ulna	Metacarpus	Carpal	Pelvis	Femur	Tibia	Fibula	Patella	Calcaneus	Astragalus	Metatarsus	Tarsal	Metapodial	Phalanges	Loose Teeth	Sesamoids	NISP	MNI
Cervus elaphus	7	2	4			7	18	4	9	5	43	15	3	18	3	1	15	22	24	17	22	18	251		508	9
Capreolus capreolus	13	3	2			6	19	17	4	9	26	10	4	11	5	3	27	28	44	18	40	35	119		443	14
Sus scrofa	1	5	1			3	9	2	3	5	9	4		3	1		8	9	3	6	3	19	104		198	6
Canis familiaris		2					3	1	3	1	1			5			1	1	4	2	4	6	13		47	2
Castor fiber	1								2		1			1				1	1			1	12		20	1
Equus caballus											2												5		7	1
Lutra lutra		1						1															4		6	1
Capra/Ovis																							3		3	1
Felis silvestris							1															1			2	1
Martes martes		1																					1		2	1
Vulpes vulpes							1																1		2	1
Halichoerus grypus																							1		1	1
Bos taurus								1																	1	1

Trustrup Relative Abundance by Element (NISP)

	Cranium	Mandible	Vertebra	Costa	Sternum	Scapula	Humerus	Radius	Ulna	Metacarpus	Carpal	Pelvis	Femur	Tibia	Fibula	Patella	Calcaneus	Astragalus	Metatarsus	Tarsal	Metapodial	Phalanges	Loose Teeth	Sesamoids	NISP	MNI
Sus scrofa	22	15	11	5	0	15	7	13	14	20	19	19	5	16	0	2	7	10	26	12	18	83	55		394	8
Bos taurus										1							1	5	1			4			12	
Bos primigenius																						1			1	
***Bos* sp.**	6	10	36	8	0	5	7	7	3	3	22	7	16	13	5	2	5	3	5	4	9	37	44	15	272	7
Cervus elaphus	11	9	16	8		4	6	7	3	3	13	9	8	11		1	3	4	12	5	7	13	35	4	192	3
Halichoerus grypus	5	3	4				1	1	1														33		48	
Phocidae	3	3	5	3			1	1		1	3	2										7	9		38	3
Capra hircus						1		1				1		1			1	1					15		21	
Ovis aries	1						4	1	1					2											9	
Ovis/Capra	1	4		2		3	1	1		2	4	3	4	2	1			3	3	1		4	36		75	4
Canis familiaris	6	3	3	3		1	2	1	1	4	3	2	1	3				1	3	1		10	6		54	2
Capreolus capreolus	1	2	3			1	2	1		2	2	1	2	2			2	2	6	1	1	9	11		51	3
Lutra lutra	1						1							1											3	1
Castor fiber						1	2	1		1												1			6	1
Alces alces							1																1		2	1
Vulpes vulpes								1															1		2	1
Equus caballus																							1		1	1
Felis silvestris																1									1	1
Martes martes										1															1	1

Havnø Relative Abundance by Element (NISP)

Appendix XI: Havnø AMS Dates

Laboratory Number	Number	Species	Element	C14 Age	AMS δ13C
UBA-20175	ADGK	Ovicaprid	tibia, sin, adult	4883±29	-21.9
UBA-20176	MFS-3	Cow	2nd phalanx, sin/pair, adult	4777±26	-24.7
UBA-20177	JFW	Cow	femur, dex, adult	4927±28	-23.2
UBA-20178	AMV	Phoca/Halichoerus	radius, dex, adult	5648±28	-11.7
UBA-20179	ANM	Canis familiaris	tibia, sin, adult	5574±31	-11
UBA-20320	MFV	Ovis aries	humerus, dex, adult	4848±41	-22.2