A contextual approach to the study of faunal assemblages from Lower and Middle Palaeolithic sites in the UK

Geoff M Smith

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I, Geoff M Smith confirm that the work presented in this thesis is my own. Where information has been derived from other sources, I confirm that this has been indicated in the thesis.

Geoff M Smith

Abstract

This thesis represents a site-specific, holistic analysis of faunal assemblage formation at four key Palaeolithic sites (Boxgrove, Swanscombe, Hoxne and Lynford). Principally this research tests the *a priori* assumption that lithic tools and modified large to medium-sized fauna recovered from Pleistocene deposits represent a cultural accumulation and direct evidence of past hominin meat-procurement behaviour. Frequently, the association of lithics and modified fauna at a site has been used to support either active large-mammal hunting by hominins or a scavenging strategy. Hominin bone surface modification (cut marks, deliberate fracturing) highlight an input at the site but cannot be used in isolation from all other taphonomic modifiers as evidence for cultural accumulation. To understand the role of hominins in faunal assemblage accumulation all other taphonomic factors at a site must first be considered.

A site-specific framework was established by using data on the depositional environment and palaeoecology. This provided a context for the primary zooarchaeological data (faunal material: all elements and bone surface modification) and helped explain the impact and importance of faunal accumulators and modifiers identified during analysis. This data was synthesized with information on predator and prey behavioural ecology to assess potential conflict and competition within the site palaeoenvironment.

Results indicate that association of lithics and modified fauna are not sufficient evidence of a cultural accumulation; two sites (Swanscombe, Hoxne) demonstrate evidence of fluvial accumulation and disturbance. Whereas at Boxgrove, hominins had primary access to all fauna, fully exploiting carcasses. At Lynford, the mammoth remains were not modified by hominins, whilst other species only indicated exploitation for marrow, which conflicts with existing interpretations. I argue that hunting and scavenging are a continuum of behaviour, not necessarily represented at each site.

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AMH	Anatomically Modern Human
BSM	Bone Surface Modification
kyr bp	Thousand years before present
KRM	Klasies River Mouth
MAZ	Mammal Assemblage Zone
MIS	Marine Isotope Stage
MTA	Mousterian of Acheulean Tradition
mya	Million years Ago
OSL	Optically Stimulated Luminescence
USO	Underground Storage Organ

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Chapter 1 Introduction

Stone tools were first identified as direct evidence for past hominin behaviour over 200 years ago by John Frere at the site of Hoxne, Suffolk (Singer *et al.*, 1993). The association of these tools with the bones of extinct animals helped establish the antiquity of the hominin lineage. Despite over a century of research into Palaeolithic subsistence behaviour there is still considerable debate about the meat-procurement methods used by these hominin populations. Charles Darwin was first to suggest that human hunting behaviour distinguished *Homo sapiens* from our closest living relatives (Darwin, 1871). Darwin's hunting hypothesis provided a subsistence framework that was compatible with numerous ethnographic accounts of hunter-gatherer communities (Kent, 1993; Lee and Devore, 1968; Lupo and O'Connell, 2002; O'Connell *et al.*, 2002a; O'Connell *et al.*, 2002b). Ethnographies amongst such populations highlighted the importance of meat acquired through the hunting of numerous species of large to medium-sized animals. In the absence of fossil and behavioural evidence for the ancestors of the human lineage modern hunter-gatherer communities were perceived as 'living fossils' (see papers in Lee and Devore, 1968) and direct descendents of ancestral human populations.

Throughout the 20th Century, archaeological excavations uncovered sites including Swanscombe, Hoxne and Boxgrove that contained deposits with stone tools and the faunal remains of large to medium-sized mammals. This archaeological evidence was interpreted as evidence of habitual large-mammal hunting by Palaeolithic hominins, similar to behaviour observed in modern hunter-gatherer populations (Bridgland *et al.*, 2006; Dart, 1959; Hart and Sussman, 2005; Roberts and Parfitt, 1999a; Stringer and Andrews, 2005; Waechter, 1976). The importance of meat in early hominin diet and the notion of hunting as the primary mode of subsistence was seen as the driving factor in the evolution of a lineage that started with *Homo habilis*, leading eventually to *Homo sapiens sapiens* (Aiello and Wheeler, 1995; Hart and Sussman, 2005; Stanford, 1999).

During the late 20th Century the subsistence behaviour of early hominins began to be reassessed; stimulated by the desire for a more scientific approach and a movement away from the descriptive cultural-historical perspective (Dominguez-Rodrigo, 2002; Hart and

Sussman, 2005). Several authors published research that undermined the privileged position of early hominin communities as primary faunal accumulators (Binford, 1981, 1985; Bonnichsen and Sorg, 1989; Brain, 1981; Bunn, 1991; Hill, 1994; Isaac, 1978, 1983; Isaac and Crader, 1981). Many studies documented the accumulation and modification of faunal assemblages by non-human agents and highlighted that some of the faunal material had been deposited in derived contexts (Isaac, 1983; Voorhies, 1969). Such studies directly questioned the axiom of spatial and temporal association between the lithic and faunal material at early Palaeolithic sites. Some of the advocates of the ‘New Archaeology’ argued that Palaeolithic populations could only compete for marginal resources and were not the specialised large mammal hunters suggested by previous analysis (Binford, 1985; Blumenschine, 1986; Hart and Sussman, 2005; Hill, 1994; Speth, 1989; Stiner, 1994; Stiner, 2002; Villa, 1990; Villa *et al.*, 2005).

The main purpose of this research project is to reanalyse faunal assemblages from several key Palaeolithic open-air sites in Britain and test the role and importance of hominin communities in the accumulation of fauna at these sites. More specifically this project aims to test the models of hominin adaptation that have been proposed at several of these localities to assess whether there is sufficient evidence of Palaeolithic subsistence behaviour.

1.1 Aims of the proposed research

The primary aim of this study is to assess the role of Palaeolithic communities in faunal assemblage accumulation. Subsequent discussion will focus on the relative importance of hominin accumulation in relation to other natural accumulation and modification agents such as river action, sub-aerial weathering and predator-scavengers. To provide a focus for this thesis the following research questions have been formulated:

1. **What taphonomic agents and site formation processes were responsible for the formation and modification of each faunal assemblage?**
2. **Is there sufficient evidence to discuss hominin meat-procurement behaviour at each study site?**
3. **Are these hominin meat-procurement strategies similar to those previously proposed?**

To answer these questions, new data has been collected and analysed from four key UK Palaeolithic localities of Boxgrove, Swanscombe, Hoxne and Lynford. The sites were selected because large lithic and faunal assemblages have been recovered at each, and faunal analysis from each has been used as evidence for a specific model of hominin subsistence and adaptation. The following chapters will present and analyse the faunal data from the four sites, and address the question of hominin involvement with the assemblages.

1.2 Justification for proposed research

This research project incorporates both broad and specific scales of analysis. For instance the chronological scale for this project covers some 450kya and encompasses periods of extreme climatic variation along with the extinction and replacement of different animal and hominin species (Roebroeks, 2006; Stringer and Andrews, 2005; Turner, 1990, 1992). Conversely, the geographical scale of this project is more specific and encompasses only a small number of known Lower and Middle Palaeolithic sites from the UK.

The British Isles' status in relation to the European mainland was as a peninsula, until some stage in the Middle Pleistocene when a breach occurred. It was then only connected during low sea level in the glacial maxima (Gupta *et al.*, 2007; Preece, 1995; White and Schreve, 2000). This geographical isolation has led to sporadic occupation during the Pleistocene and the probable local extinction of hominin populations (Stringer and Andrews, 2005). However, the wider impact of this research is of course applicable to Europe and beyond and it is hoped the methodology developed for this project can be expanded to include other sites in mainland Europe such as Wallertheim and La Cotte de St Brelade (Gaudzinski, 1995; Scott, 1980, 1986). The current project is not intended to provide a comprehensive comparison of change or continuity in hominin subsistence strategies across different time frames, geographical locations and environmental niches. Instead, the project is more methodological and intends to demonstrate the need to assess hominin behaviour within a framework that considers all other agents of bone accumulation by using four specific study sites as examples.

In part this research aims to answer Gifford-Gonzalez's (1991) call to use a multi-disciplinary approach when studying hominin subsistence rather than relying solely on primary evidence from faunal analysis. In addition, re-analysis of the Swanscombe faunal assemblage, as part of my Master's degree research (Smith, 2003a), indicated that natural agents were important faunal accumulators and modifiers at the site and suggested that the faunal assemblage represented a secondary accumulation. As a consequence of my Master's research findings I argue that previous interpretations of hominin behaviour for Swanscombe (see Binford, 1985; Waechter, 1968, 1969) were incompatible with my reanalysis. The reinterpretation of sites using a new methodology that focuses on all agents of faunal assemblage modification, not just hominin signatures, provides a clearer understanding into the role of hominins at these locations.

1.3 Summary

The sections above have highlighted the key issues, questions and background to the current study. The issue of hominin subsistence behaviour is only one facet of this study and is encompassed within the wider scope of other site formation processes and taphonomic agents. The following chapters will detail the methods and techniques for studying and interpreting the role of hominins at key Palaeolithic sites and whether more detailed discussion of meat-procurement behaviour can occur.

Previous models of hominin subsistence behaviour at a general and more specific European and British scale will be discussed in Chapter 2. At the end of Chapter 2 several possible scenarios are outlined and the 'signatures' that would support each will be discussed throughout the analysis to help determine which scenarios can be discounted and which require further consideration. Chapter 3 documents the methodological approach used and justifies the methods and techniques employed. Chapter 4 provides specific information about the study sites, including climatic and palaeoenvironmental evidence, and details previous interpretations of hominin subsistence behaviour derived from the sites. Chapters 5 to 8 present the results of primary zooarchaeological analysis, and discuss the role of various accumulation agents at each of the study sites. These chapters also present analysis that either supports or questions previous models of hominin subsistence. Chapter 9 draws comparison between each study site and assess the data in the wider European context and draws out the implications for this research in relation to the evolution of human hunting behaviour. The study concludes with a summary of the research and draws out potential new avenues for future research.

Chapter 2 Lower and Middle Palaeolithic hominin subsistence

Pleistocene deposits containing stone tools and modified fauna indicate a hominin presence at or around a site (Bunn and Kroll, 1986; Gifford-Gonzalez, 1989a, 1989b; Pickering, 2002; Roberts and Parfitt, 1999a) but what these associations mean in terms of early hominin meat-procurement behaviour, or whether they indeed indicate a particular behaviour, is still the subject of debate (Lewin, 1999; Stopp, 1997). Such associations have been interpreted as evidence for both active hominin hunting behaviour and more passive scavenging behaviour (Binford, 1985).

The specific aim of this research is to assess the role and importance of hominin communities in the accumulation of faunal assemblages at key Lower and Middle Palaeolithic UK sites. Although lithic tools and modified fauna indicate a hominin presence at a site, the association between these two datasets cannot simply be assumed but must be demonstrated (Stopp, 1997). The aim of this study is not to document change or continuity in hominin subsistence behaviour over a chronological period, but rather to assess such behaviour within a more specific site context to assess all agents of faunal accumulation. The analysis and elimination of other factors as the primary agent(s) of faunal accumulation will provide a stronger determination of cultural causality and more detailed analysis and understanding of past hominin behaviour within the site’s palaeoenvironmental context. This chapter provides the background to the research I carried out and highlights some of the key issues relating to the study of past hominin subsistence behaviour.

2.1 The temporal and spatial context

Before discussing the current debates surrounding hominin meat-procurement behaviour it is important to define the spatial and temporal context of this study. The Palaeolithic timeframe begins with the first emergence of stone tools in Africa c. 3mya and lasts until the end of the Devensian ice age (Lewin, 1999; Stringer and Andrews, 2005). Different regional frameworks have been developed across the globe but in Europe the Palaeolithic has been further subdivided into Lower, Middle and Upper based on the presence/absence of specific tool types (Lewin, 1999; Stringer and Andrews, 2005). The current project will only focus on the Lower (c. 700kya-300kya) and Middle Palaeolithic (c. 300kya-30kya). A comparison of lithic tool typologies at different Palaeolithic localities can only provide a relative age for such sites. This can be obviated by the use of absolute dating techniques such as Optical Spin Luminescence, which can provide a more accurate date for a site and help assign deposits to a specific Marine Isotope Stage (MIS). By combining absolute dating determinations with data from comparative mammalian biostratigraphy for certain indicator species, sites can be positioned within a regional framework (see Figure 2.1).

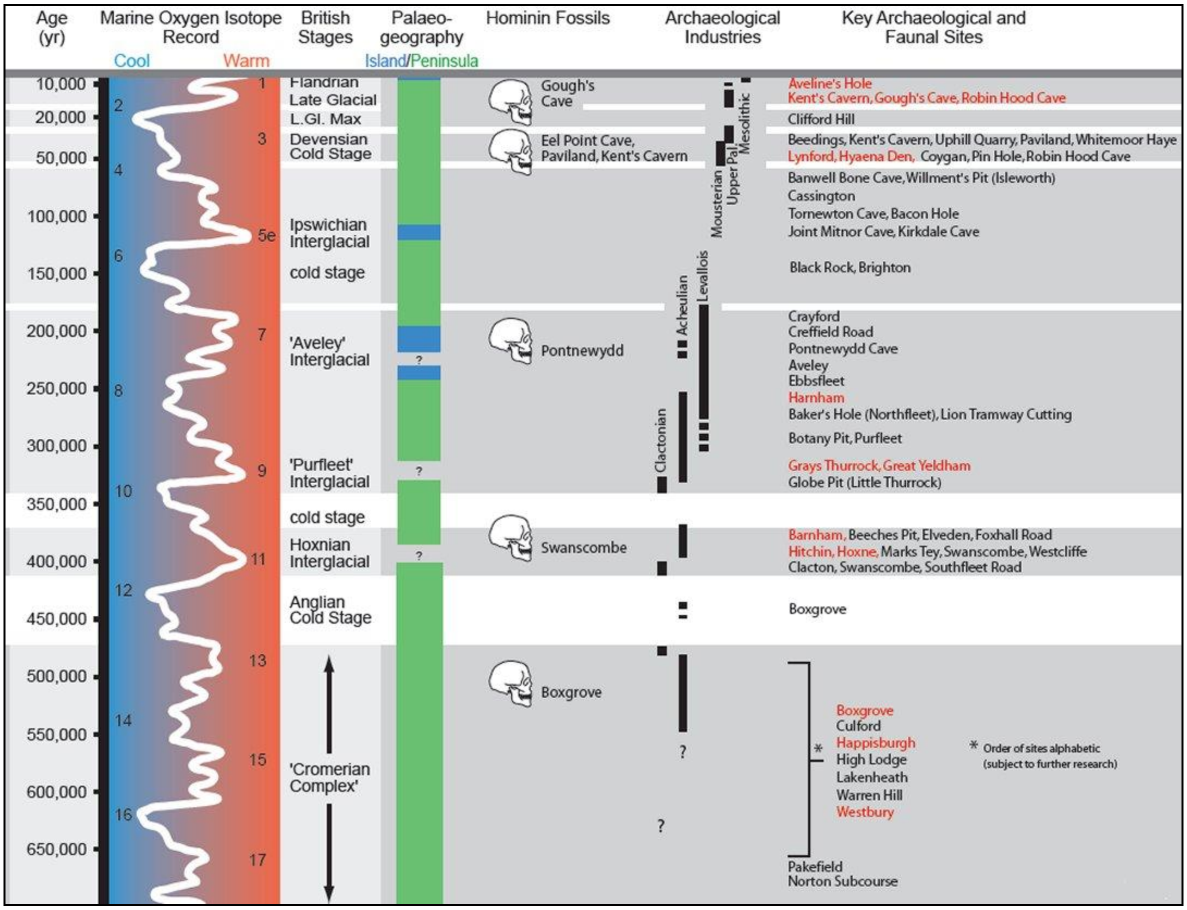

Figure 2.1 Marine Isotope Stages during the Pleistocene with key British archaeological sites Modified from Ancient Human Occupation of Britain website (http://www.nhm.ac.uk/hosted_sites/ahob/index_2.html)

Current evidence suggests that the first hominins appear in Britain during the Cromerian complex (c. 600kya) (Parfitt *et al.*, 2005), and there then follows several localised episodes of extinction and repopulation throughout the Pleistocene (Parfitt *et al.*, 2005; Preece, 1995). The position of each of the study sites within the British chronological framework is illustrated above (see Figure 2.1) along with other major Lower and Middle Palaeolithic localities. This thesis focuses on UK sites from different timeframes, and with varying locations, environmental conditions and hominin populations. The Lower Palaeolithic sites of Boxgrove, Swanscombe, and Hoxne are situated in the major Interglacials of the Cromerian complex and Hoxnian; these sites are associated with populations of *Homo cf. heidelbergensis/neanderthalensis* (Stringer and Gamble, 1993). In contrast the Middle Palaeolithic is represented by a single site at Lynford and situated within the Devensian Glacial event with stone tools that are associated at other sites with *Homo neanderthalensis* (Boismier, 2003, in press-b).

Having defined the context and associated hominin populations I now provide a historical overview of research into hominin meat-procurement behaviour at a general scale and then more specifically at the European scale.

2.2 Hunting and scavenging: the state of the debate

During the late 19th and early 20th century, research into Pleistocene deposits in Africa, particularly at Olduvai Gorge, demonstrated that archaeology from these sites was of greater antiquity than any of the material recovered from European excavations (McKie, 2000; Stanford, 1999; Stringer and Andrews, 2005). This evidence currently supports the ‘Out of Africa’ model for human evolution and dispersal into Europe and Asia (see section 2.1) (Langbroek, 2004; Stringer and Andrews, 2005). The evolution and movement of different hominin species has resulted in continued interest in the type, variation and geographical emergence of different subsistence strategies. Many researchers have focussed on either the initial emergence of hominin meat-eating behaviour or the evolution of Anatomically Modern Human (AMH) hunting behaviour. The primacy of AMHs as habitual large mammal hunters has frequently led to the dismissal of earlier hominin species as lacking the social, communicative and anatomical characteristics necessary to hunt and reduced their subsistence behaviour accordingly (Stanford, 1999).

2.2.1 Hominin large-mammal hunting

The discussion of Palaeolithic hominin subsistence practices has been of primary concern to researchers since Charles Darwin first published the *Descent of Man* (Darwin, 1871). Indeed, Darwin postulated that the emergence of humans, as a species distinct from other primates, stemmed from their ability to evolve to varying climatic conditions not only biologically, but also socially and culturally. Darwin (1871) stated that hominisation began once our ancestors abandoned the trees, adopted a bipedal gait and used their free hands to make and use tools, essential for hunting and carcass-processing (Dominguez-Rodrigo, 2002). The presence of lithic tools and faunal remains was seen as evidence of human subsistence behaviour, and the consumption of large quantities of animal protein was perceived as a behaviour type that distinguished humans from other living primates. Nevertheless, the primacy of meat-eating in human evolution was supported by the widespread recovery of lithic tools and the bones of extinct fauna from open-air and cave deposits, at African sites such as Swartkrans, Makapansgat, Koobi Fora and Olduvai Gorge (Dart, 1959). Thus these sites were seen as direct evidence of human predation. Dominguez-Rodrigo (2002) has noted that the global distribution of sites exhibiting a similar archaeological signature (i.e. only stone tools and bones survive) led to the widespread acceptance that hunting was the major method of past hominin subsistence behaviour (Behrensmeyer, 1987; Binford, 1981, 1985; Gifford-Gonzalez, 1991; Isaac, 1983; Stanford, 1999) more recently referred to as the ‘Hunting Hypothesis’ (Stanford, 1999). The initial focus of this research was Western Europe, on exposures uncovered within large river valleys, at sites such as Swanscombe, Abbeville, Torralba and Bilzingsleben (Bridgland, 1994; Bridgland *et al.*, 2006).

Hunting behaviour was seen as a driving force for biological evolution and became a diagnostic behaviour to illustrate the emergence of ‘humanity’ in our evolutionary past and distinguish our species from the wider primate community (Stanford, 1999). When early hominin fossils were discovered in South Africa (*Australopithecus africanus*) (Dart, 1959) and suggested as a possible ‘missing link’ between apes and humans it was initially assumed that hunting was practiced as part of their subsistence regime (see 2.2.2).

The ‘hunting hypothesis’ received widespread popular and academic support during the early and mid 20th Century as an interpretive framework to explain the adaptation of hominin populations to the savannah environments and also the behavioural signatures recovered at numerous archaeological sites (Bunn, 1991; Bunn and Kroll, 1986; Egeland *et al.*, 2004; Shipman, 1983, 1988; Stanford, 1999; Stopp, 1997). The hunting paradigm reached its peak during the mid 1960s coinciding with the *Man the Hunter* conference (Lee and Devore, 1968). The subsequent publication focussed mainly on ethnographic accounts to demonstrate that hunting had always been a part of human society (Dominguez-Rodrigo, 2002). Washburn and Lancaster (1968, p293) stressed the importance of hunting to early hominins as “a social adaptation [for] all populations of…*Homo*…[along with] *Australopithecus*…who was already a hunter”. Accounts such as these indicated that hunting was an efficient method of adapting to different environments and emphasised the stress-free life style of hunter-gatherer communities (Dominguez-Rodrigo, 2002). This interpretation of Hunter-Gatherer lifestyles as stress free was a result of the social conditions during the 1960s and 70s which emphasised social and economic co-operation. Such a framework proved attractive to researchers attempting to explain early hominin survival and adaptation in open savannah environments. The large herds of herbivores provided a plentiful food supply and the social grouping of hominins provided protection from the large predators also present within this environment (Hart and Sussman, 2005; Stanford, 1999).

During the 1970s Glynn Isaac (and colleagues) shifted the paradigm away from the actual process of hunting and argued instead that hominin social co-operation was the major evolutionary driving force (Isaac, 1978, 1982; Isaac and Crader, 1981). Issac’s ‘Food Sharing Hypothesis’ stated that hominins habitually brought both plant and animal resources back to a specific location that provided a social focus, the ‘Home Base’ (Isaac, 1983). The association of stones and bones at these archaeological sites was interpreted as evidence for hominin home base locations with an accompanying social package (Isaac, 1983). In this system males hunted whilst females gathered plant foods, an observation that had been supported by numerous ethnographic studies amongst modern hunter-gatherer populations (Krusimba, 2003; Lee and Devore, 1968). Although Isaac had shifted the focus away from hunting and focussed on food-sharing as the evolutionary driving force it “…nevertheless left [these communities] recognisably human…”(Lewin, 1999 p150). However, such an interpretation relied on analogue comparisons with the social structure of modern hunter-gatherer groups; to what degree such continuity in hominin social behaviour existed between modern populations and hominin populations in the deep past is highly debateable. Although Isaac had shifted the focus from specific hunting behaviour and onto social co-operation he had not discounted either hunting or scavenging as viable subsistence strategies but instead suggested both were viable (Isaac, 1983). Subsequently, Isaac shifted the focus further and addressed the role and importance of non-cultural factors such as rivers and predator-scavengers in the accumulation of lithic tools and faunal remains at early sites in order to more clearly understand the type and importance of hominin behaviour at such sites (Isaac, 1983; see section 2.2.2).

The identification of stone tool modifications on faunal remains from Olduvai Gorge (Bunn, 1981) appeared to provide the clearest evidence of a human origin for these assemblages. Further analysis of cut marks and predator tooth marks highlighted differences between them, both in their morphology and cross-section (see Chapter 3 for further discussion and Fisher, 1995). The ability to distinguish between such modifications provided a more quantifiable and definite identification of hominin involvement with faunal remains, instead of relying on analogue comparisons of butchery practices by modern hunter-gather populations (Lee and Devore, 1968). The evidence for cut marks from sites with the earliest evidence for hominin populations served to emphasise the importance of meat-eating and, more importantly, the early role that hunting played in the evolution and emergence of different hominin species. However, the unequivocal use of cut marks as evidence for hominin hunting behaviour was severely tested by Binford's research (Binford, 1981, 1985).

The 'hunting hypothesis' provided an interpretive paradigm for evolutionary behaviour to distinguish humans not only from our closest living relatives but also from other species within the hominin genus, although this had to be slightly modified when evidence for hunting behaviour by chimpanzee populations was published (Dominguez-Rodrigo, 2002; Sayers and Owen Lovejoy, 2008). Such data illustrated that hunting was not an exclusively hominin behaviour but one shared with apes, notably chimpanzees. Nevertheless, it is important to emphasise that chimpanzee hunting is *ad hoc* and entirely focussed on mammals smaller than the hunters themselves (Harding and Teleki, 1981; Hart and Sussman, 2005). The 'hunting hypothesis' was modified to incorporate the data from chimpanzee studies and suggest instead that hunting behaviour had not emerged rapidly, as postulated by Darwin (1871), but had evolved over a longer period of time (Stanford, 1999). Thus hominin hunting behaviour developed from occasional dietary supplement to an increased dependence on meat that gradually resulted in the development of hunting behaviour that allowed for the procurement of almost every kind of animal regardless of size or habitat (Aiello and Wheeler, 1995; Hart and Sussman, 2005; Nitecki and Nitecki, 1987; Sayers and Owen Lovejoy, 2008). To summarise, interpretive shifts that incorporated a more critical analysis of site and assemblage formation rigorously tested the hunting hypothesis and reassessed the subsistence capacities of the earliest hominin communities.

2.2.2 Marginalised populations: Hominin scavenging behaviour

The emergence of 'New Archaeology' during the 1970s and 1980s resulted in an intensive period of both theoretical and methodological change that culminated in a reinterpretation of early hominin capacity and meat-procurement behaviour (see particularly Binford, 1981, 1985; Brain, 1981). The 'New Archaeology' stimulated a wealth of actualistic and experimental studies that focussed on site formation, assemblage modification, and animal behavioural ecology along with numerous ethnographic accounts of modern hunter-gatherers (Binford, 1978; Kruuk, 1972). Archaeological research attempted to provide information on cultural and carnivore modification as well as background taphonomic information on non-cultural and non-carnivore bone surface modifications such as hydraulic action, terrestrial weathering, burning and root etching (Behrensmeyer, 1978). These studies aimed to document hominin and natural bone modification signatures in modern faunal assemblages to provide better distinction of these processes in the archaeological record (Olsen and Shipman, 1988). Throughout the 1980s research into early hominin subsistence behaviour underwent serious reassessment and a considerable period of 'dehumanisation' in which hominin communities were assessed within a palaeoenvironmental context and in competition with other predator species (Binford, 1981; Blumenschine, 1986; Brain, 1981; Bunn, 1981, 1983; Shipman, 1983). Gradually the results from such research began to question and undermine hunting as the only viable meat-procurement behaviour practiced by early hominin populations.

Reanalysis of material from South African cave deposits illustrated that faunal assemblages, including hominin remains, had been accumulated through the actions of predator-scavengers, particularly leopards (Brain, 1981). Brain's (ibid) extensive taphonomic analysis, combined with detailed actualistic studies of predator-scavenger and human carcass modification methods, produced an interpretation at odds with Dart's "killer ape" scenario (Dart, 1959). Whereas Dart had previously identified the bone deposits at these caves as a human accumulation, Brain highlighted similarities with modern predator-scavenger accumulations. The most convincing evidence that hominins were prey rather than predator were canine tooth pits on hominin skull fragments that aligned perfectly with the position of these teeth in modern leopard skulls (see Figure 2.2). This work illustrated the dangers of using the perceived association of stone tools and faunal remains as a proxy for hominin accumulation and hunting behaviour.

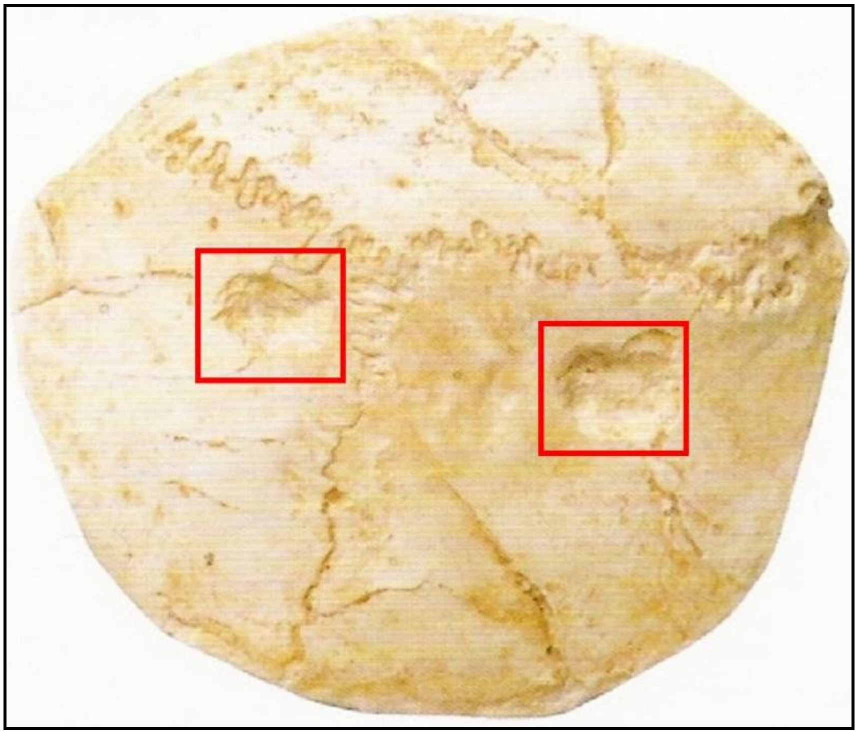

Figure 2.2 Leopard canine marks (indicated by boxes) on hominid skull fragment Modified from McKie (2000 p48)

Throughout the 1970s and 1980s Glynn Isaac gradually modified his theories about hominin actions at early archaeological sites (Isaac, 1983). Isaac's work in East Africa, particularly at sites in Olduvai Gorge, led him to caution against the assumption that these collections of bones and stones were solely evidence of past hominin hunting (Isaac, 1978, 1983). Isaac had modified the traditional hunting paradigm and suggested that social co-operation and food sharing at specific focal points, or home bases, provided more of an evolutionary driving force than hunting behaviour itself (Isaac, 1978). His work at numerous East African sites, notably Koobi Fora, highlighted that numerous factors could potentially lead to the accumulation of stone tools and animal remains at these sites and that these agents and processes needed to be considered alongside more identifiable hominin modification signatures (Isaac, 1983). Isaac and Crader noted that "concentrations and dispersions of artefacts and bones may or may not coincide" (1981, p43). His work at early East African localities led him to describe and define a number of different types of sites based on the distribution and association of lithic and faunal assemblages (Isaac and Crader, 1981) (see Figure 2.3).

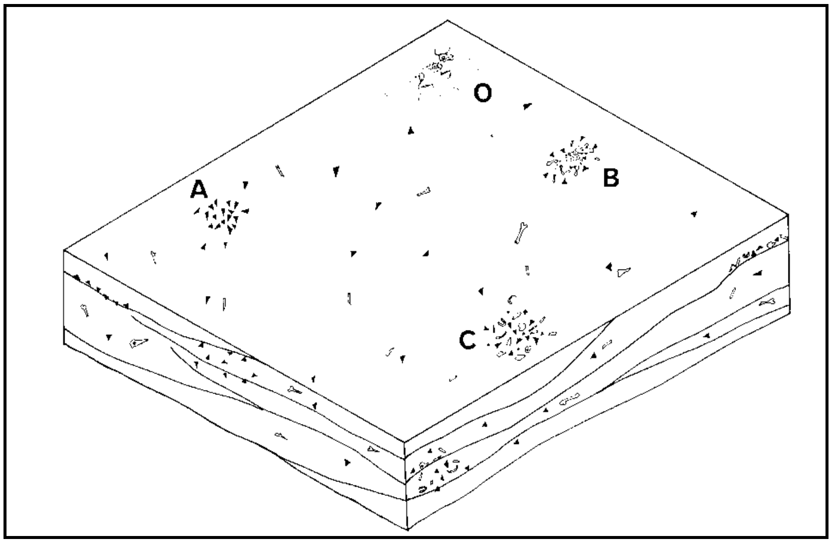

Figure 2.3 Isaac's configurations of artefacts and bones in sedimentary formations from East Africa[1] Modified from Isaac and Crader (1981, Figure 3.1)

Despite the presence of bone fragments and stone tools in the same deposits, Isaac noted that such accumulations may in fact be causally unrelated and stressed the need to highlight all factors of assemblage accumulation and demonstrate cultural causality (Bailey, 1983, 2007; Isaac, 1983; Vaquero, 2008). For example, faunal material and lithic material might be independently washed along by a stream and then re-deposited together as a secondary accumulation (see Figure 2.4 and Figure 2.5). Isaac's interpretation was reliant on the accurate identification of hominin behaviour as the primary cause of faunal accumulation

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[1] Definitions from Isaac and Crader (1981, p43)
Type A- sites containing a concentration of artefacts but little or no bone materials
Type B- sites with artefacts associated with a single carcass of a large animal
Type C- sites with a concentrated patch of artefacts and bones from several species
Type D- sites where artefacts, with or without bones, are dispersed throughout several sedimentary horizons
Type G- sites where material has been transported and redeposited
Type O- sites containing bone material only- in these cases it is *difficult to demonstrate active hominin involvement in the process of accumulation* (emphasis added).

not only in the form of tool production but actual involvement with the faunal remains (Isaac, 1983). In order to demonstrate that faunal assemblages were the direct result of hominin subsistence behaviour he attempted to employ a holistic approach that highlighted all other taphonomic agents that were operating at a site (Isaac, 1983) (see Figure 2.4). Nevertheless, Isaac did not dismiss either hunting or scavenging as a viable subsistence strategy for these early hominin communities.

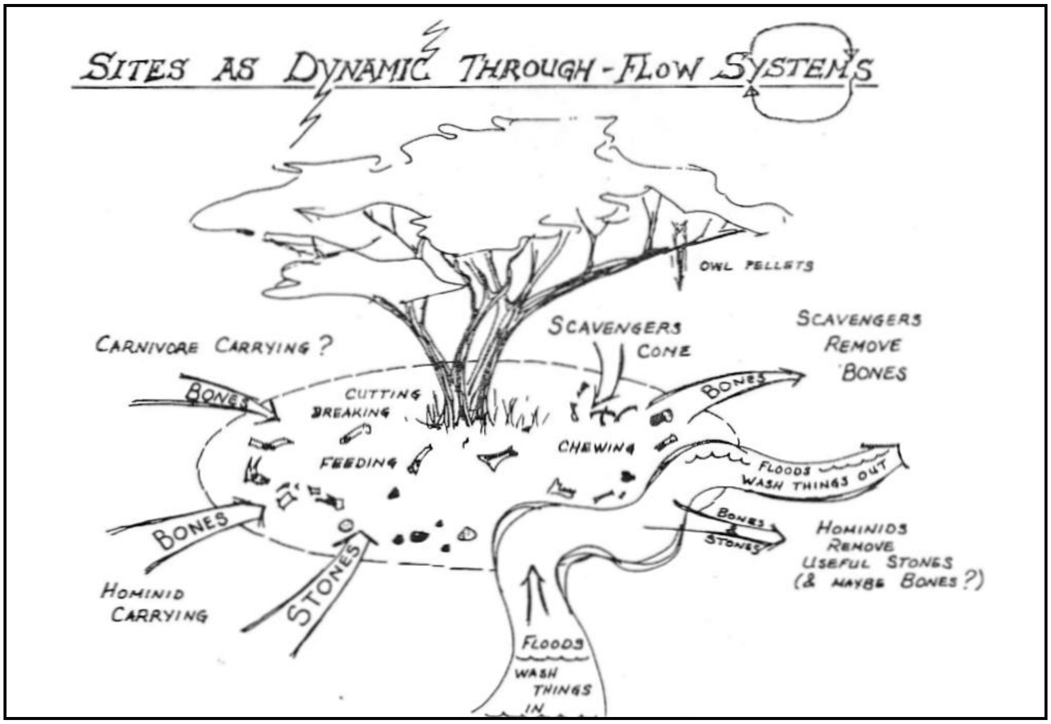


Figure 2.4 Complexity of faunal accumulation and site formation at Palaeolithic locales
Isaac (1983, Figure 6)

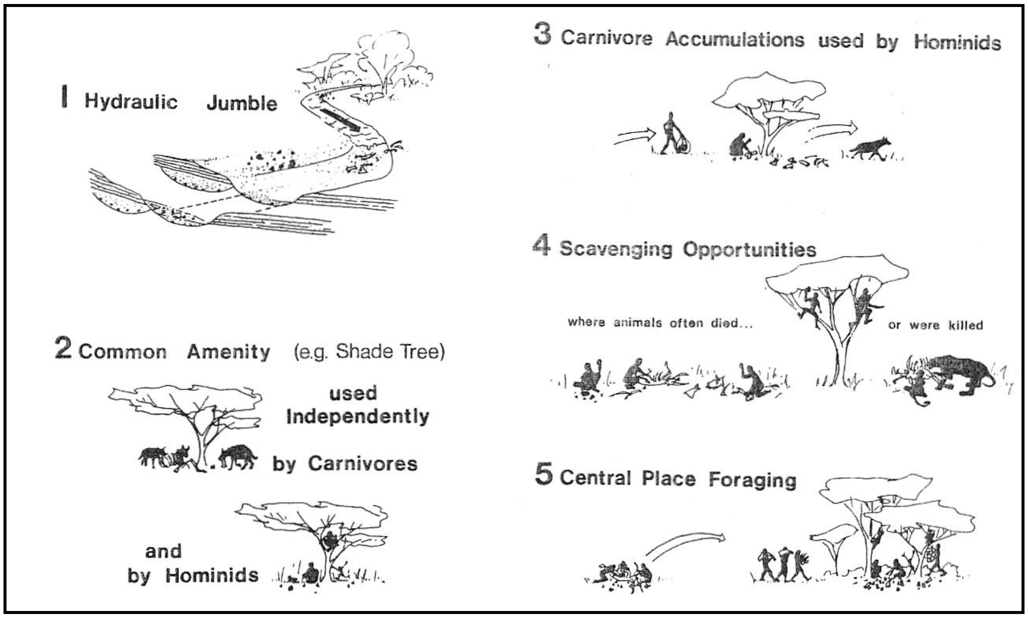


Figure 2.5 Faunal accumulation and modification agents at east African Palaeolithic sites Isaac (1983, Figure 3)

Isaac's contemporary Lewis Binford was undertaking similar actualistic and ethnographic work amongst the Nunamiut communities in an attempt to understand the patterning in faunal assemblages from early archaeological sites (Binford, 1978, 1981, 1985; Binford, 1987a). Binford's work led to a vociferous attack on the hunting paradigm and its assumptions for hominin evolution and behaviour. He used 'Middle Range Theory' to bridge the gap between the 'active' behavioural signatures witnessed in the present through ethnoarchaeological and actualistic studies and the 'static' data recovered from the archaeological record (see especially Binford, 1978, 1981; Isaac, 1983). More specifically, Binford used skeletal profiles from modern hunter-gatherer and predator-scavenger kills and compared these with the data from faunal assemblages at early archaeological sites (Binford, 1981, 1984, 1985; Binford, 1987a; Binford, 1987b).

Binford produced detailed information about the movement of Nunamuit populations within their landscape and recorded different types of seasonal sites (Binford, 1978), which included short term hunting stands and more permanent village settlement. He (ibid) studied the faunal remains from short and long term sites to record differences in Nunamiut carcass-processing patterns and how this could relate to faunal assemblages from sites in the archaeological record. Binford documented the location of different bone surface modifications and how these corresponded to particular carcass-processing behaviours. For instance, chop marks on/around bone epiphyses often related to disarticulation whilst cut marks on long bone shafts demonstrated evidence for butchery and meat removal (Binford, 1981). By providing detailed descriptions of the location and type of bone surface modification, Binford hoped to demonstrate that specific types of modifications could be related to specific subsistence behaviours and hence indicate a specific meat-procurement strategy (Binford, 1981). By combining both analytical techniques, Binford concluded that the faunal assemblages from the earliest African sites, particularly from FLK Zinj, were principally accumulated by predator-scavengers and subsequently scavenged by hominin communities (Binford, 1981). He identified cut marks on skeletal regions where meat was limited and demonstrated that hominin cut marks overlapped previous predator-scavenger modifications. He employed a similar approach to study faunal assemblages from Lower Palaeolithic sites in Africa (particularly Olduvai Gorge) and Europe (Swanscombe and Torralba) (Binford, 1985, 1987b; Klein, 1987) along with the more recent Middle Stone Age site of Klasies River Mouth (Binford, 1984; Klein, 1989; Klein *et al.*, 1999). Archaeological interpretations of hominin subsistence behaviour shifted dramatically during the 1980s. Some authors no longer considered hominin communities as big game hunters (Binford, 1981, 1985; Blumenschine, 1986, 1992; Selvaggio, 1998b, 1998c), but as marginal scavengers. Binford concluded that hunting behaviour did not truly emerge until the evolution and dispersal of Anatomically Modern Humans (AMH). He emphasised the primacy of AMH and stressed that other hominin species lacked the anatomical, social and technological capacity for large mammal hunting. Importantly for this project, these studies highlighted the value of employing a taphonomic methodology in order to tease out information regarding the formation history of both faunal and lithic assemblages.

Although the 1980s witnessed a more scientific and holistic approach to the study of early hominin subsistence many theoretical and methodological problems arose. Despite extensive ethnoarchaeological and taphonomic investigation, many scholars argued that even today there is significant variation in processing techniques amongst modern hunter-gatherer groups that inhabit different environmental niches (Blumenschine, 1986; Kent, 1993). Therefore, if comparisons between the butchery signatures of modern populations are difficult, accordingly it is even more complicated to project such processing strategies further back into human prehistory. As well as theoretical problems about the applicability of using data from modern hunter-gatherer groups there arose other methodological issues of contention. Frequently, reinterpretations often relied upon published data (e.g. Binford's analysis of FLK Zinj) without first hand re-analysis and recording of the faunal assemblage and its modification (see particularly Binford, 1981). This uncritical approach is dangerous and relies on four assumptions:

1. There was no preferential bias towards specific bone portions during excavation;
2. The species data reported has been correctly identified;
3. The faunal list provided is complete;
4. The bone surface modification has been correctly identified and their locations accurately reported.

The first assumption is particularly pertinent considering the ongoing debate regarding the Klaises River Mouth (KRM) assemblage from South Africa (see especially Binford, 1984). At KRM, Klein's initial analysis suggested that the faunal assemblage represent evidence for hunting by hominin communities, though this was refuted by Binford who suggested that the assemblage indicated marginal scavenging behaviour (Binford, 1984; Klein, 1987, 1989; Klein *et al.*, 1999). Turner's (1989) work identified that during excavation only the most 'diagnostic' elements were kept which produced an artificially deflated value for bone shaft fragments, which are less readily indefinable, compared to epiphyseal fragments. Therefore, he has argued that the pattern displayed at KRM is a result of the excavation and recovery methodology rather than an accurate representation of hominin behaviour (Turner, 1989).

The 1980s reassessment of early hominin subsistence capacities moved away from previous descriptive, narrative approaches and attempted to apply scientific and statistical techniques to the study of hominin subsistence, with mixed results. The studies undertaken attempted to provide a clear bridge between 'static' data and 'active' behaviour through actualistic and ethnoarchaeological research. This combined approach provided a greater insight into what the location of bone surface modification on specific elements, and on the skeleton as a whole, may represent in terms of past hominin behaviour. In addition, the 'New Archaeology' identified predator-scavengers, along with other natural factors, as viable agents of faunal accumulation and modification alongside these early hominin communities. Interpretations of early hominin subsistence emphasised the differences between strategies, compared with later populations of AMH. More specifically, such interpretations focussed on whether early hominin populations possessed the social and technological capacity for complex large mammal hunting. These interpretations reduced hominin populations to static, marginal communities without the capacity for planning or curation and reliant on the scavenging opportunities from other carnivore kills. However, the critique of the theoretical and methodological approaches used by the 'New Archaeology' together with research into carnivore behavioural ecology and excavation at certain sites, such as Boxgrove, necessitated a re-evaluation of hominin meat-procurement strategies and further reassessment of hominin subsistence behaviour (Dominguez-Rodrigo, 2002)

2.2.3 Hominins as hunters and scavengers

Previous theories about hominin subsistence have focussed on the social, economic and evolutionary benefits of increased meat in early hominin diet (Aiello and Wheeler, 1995; Binford, 1985; Dart, 1959; Isaac, 1978, 1983). Frequently however, the active or passive nature of the procurement strategy (i.e. hunting vs. scavenging) has implications in terms of the 'humanity' or 'primitive' nature of these hominin communities. Previous interpretations of hominin subsistence have portrayed such behaviour as directly ancestral to modern hunter-gatherer behaviour (Lee and Devore, 1968), or have stressed the uniqueness of AMH subsistence behaviour whilst simultaneously highlighting perceived technological and behavioural limitations that would have restricted the behaviour of pre-*sapiens* populations (Mellars and Stringer, 1989). This variation in interpretive frameworks has caused significant polarisation in understanding of subsistence behaviour. The discovery of notable European sites, such as Boxgrove and Schöningen (see below), have drastically reshaped previous interpretations of Lower Palaeolithic subsistence and narrowed the gap between hunting and scavenging as separate subsistence behaviours. At Boxgrove in particular there is apparent evidence for the exploitation of all animal size-classes with evidence for hominin primacy over other predator-scavengers on many of the carcasses. Current debates have shifted away from a purely evolutionary perspective, instead attempting to identify the behavioural 'missing link' between early hominin hunting and scavenging behaviour. Focus has shifted towards positioning hominins back in their palaeoenvrionmental contexts in order to understand resource availability and hominin interaction and competition with other species in this environment (e.g. Stiner, 1994).

For this purpose additional focus has been on a more accurate identification of predator-scavenger bone surface modification (Dominguez-Rodrigo, 1999b). In addition, the analysis of early hominin and predator-scavenger habitat preference has helped highlight areas of overlap which could have provided opportunities for hominin resource scavenging (both active and passive) from predator-scavenger kills (Dominguez-Rodrigo, 1999b). The use of carnivore behavioural ecology to hypothesise about the availability of scavengable resources for hominin populations is not new (Blumenschine, 1986, 1988; Dominguez-Rodrigo, 1996; Dominguez-Rodrigo, 1997, 1999b; Kruuk, 1972). However, such studies have served to illustrate considerable variation in the amount of time carnivores spend consuming carcasses. Dominguez-Rodrigo (2002) highlighted that lions consuming prey within a riparian environment can often take hours over a single carcass and leave little, if any, resources. Similarly, the same author documents that carcasses on the exposed African savannahs attract scavengers such as hyaenas quickly and would have provided a limited time frame for early hominins to access carcass resources (Dominguez-Rodrigo, 1999b). Several authors have concluded that the resources available to scavengers from carnivore kills were minimal and the energy expended scavenging outweighs the benefits (see particularly Dominguez-Rodrigo, 2003a, 2003b). These authors entirely reject the notion of scavenging as a sustainable subsistence strategy. Nevertheless, some authors have still advocated a multi-stage model for faunal assemblage accumulation at early hominin sites (Selvaggio, 1994, 1998a, 1998b, 1998c; Selvaggio and Wilder, 2001), and have used overlapping predator-scavenger and hominin modifications to suggest that hominins were scavenging from either predator kills or natural deaths. Some authors have highlighted that animal mass death events provide plentiful resources and scavenging opportunities for both hominin and non-hominin predators (Conybeare and Haynes, 1984; Haynes, 1985, 1987, 1988b, 1991; Stopp, 1997). However, the rarity of such mass death episodes provides a strong argument against subsistence behaviour based on such events.

Other researchers have attempted to address the inherent bias present in studies of Palaeolithic subsistence and emphasised the potential role and importance of plant resources in past hominin diets (Laden and Wrangham, 2005; O'Connell *et al.*, 2002a; Priddle, 2004). Investigations into the importance of these resources have been largely overlooked due to the poor preservation of such evidence in Pleistocene deposits. Landen and Wrangham (2005) have highlighted that underground storage organs (USOs) would have provided a fairly constant source of resources that could have provided back-up during periods when sources of animal protein were scarce. However, the distribution and availability of such resources outside the African savannah environment varies considerably as seasonal variability and latitude increase (Kuhnlein and Turner, 1991; Priddle, 2004 also see below for further discussion).

Undermining of the ‘habitual scavenging hypothesis’ has led to the re-emergence of the ‘hunting hypothesis’ but without the associated social and economic implications (Dominguez-Rodrigo, 2002). Some authors have recently incorporated hominins into the wider carnivore guild (Stiner, 2002) and highlighted that a sustained hominin presence outside of Africa appears to coincide with the extinction of the larger sabre tooth felids and hyaenas and subsequent replacement with the current suite of African carnivores (Arribas and Palmqvist, 1999). Whether this demonstrates an inability to compete with such large carnivores or an absence of suitable archaeological evidence is unclear. Conversely, the extinction of these large carnivores could relate to hominin dispersal and the ability of hominin species to compete effectively with other carnivore species. Importantly, hominins are beginning to be considered within a palaeoecological context and species guild. Rather than considering hominin behaviour as separate and unique it is essential to assess how predator and prey behaviour could have influenced past hominin behaviour and vice-versa.

The above review has highlighted that interpretations of past hominin subsistence have changed considerably during the last 40 years, from more complex social, food sharing models (Isaac, 1978, 1982, 1983) to more animalistic models for hominin subsistence (Binford, 1981, 1985; Dominguez-Rodrigo, 2002; Klein *et al.*, 1999; Lewin, 1999; Selvaggio, 1994, 1998b, 1998c; Stiner, 1994; Stopp, 1997). Current evidence suggests that early hominins possessed the ability to actively procure significant quantities of animal protein at numerous locations and in varying time periods and geographical settings. Such a variation suggests that hominin subsistence behaviour was perhaps more flexible than previous interpretations had shown and could incorporate both active and passive approaches depending on ecological conditions and resource availability (see Figure 2.6).

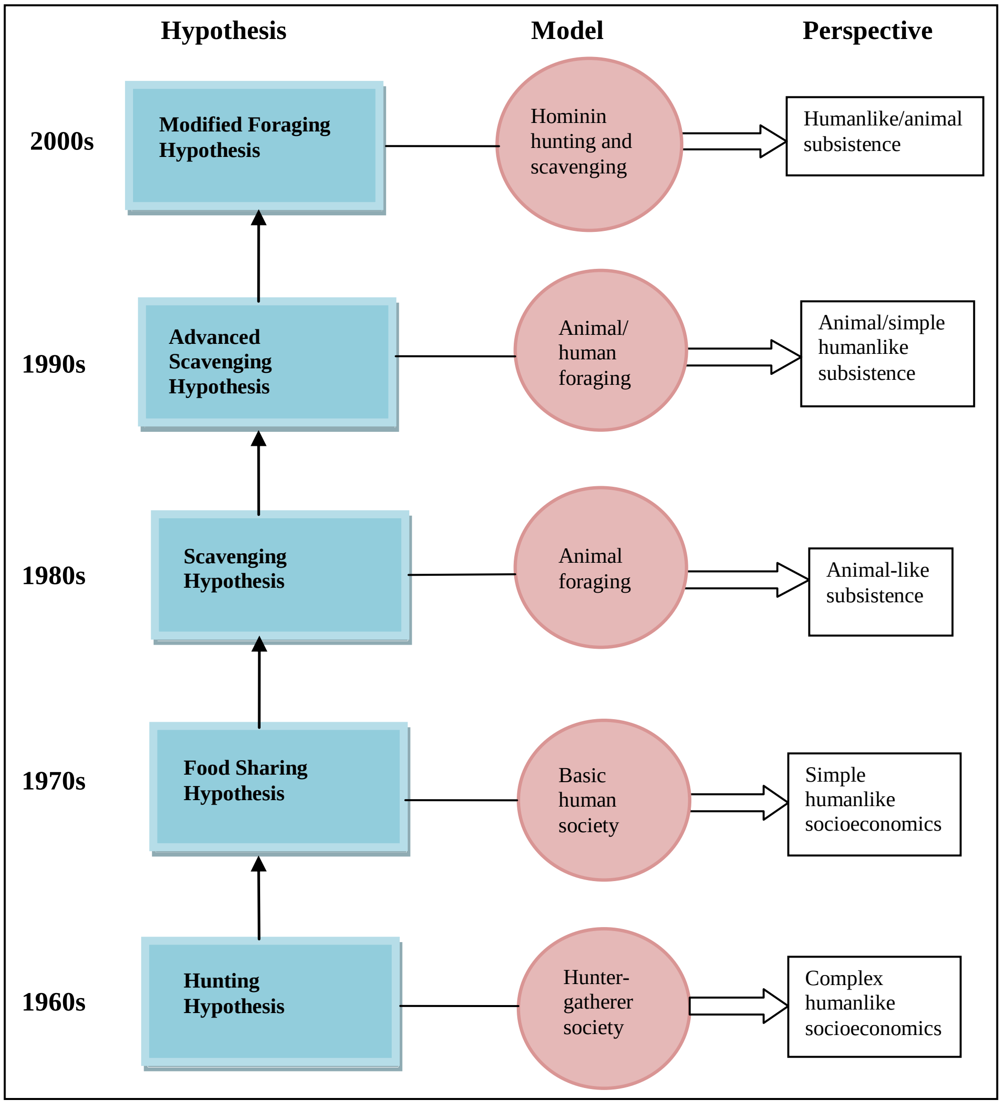


Figure 2.6 An evolution of theories for hominin subsistence for the last 40 years Modified from Lewin (1999, p149)

The following sections will provide more-detailed evidence for hominin subsistence behaviour during the European Lower and Middle Palaeolithic, and more specifically in the UK.

2.3 Hominin subsistence in Europe: the state of the debate

Most models for early hominin subsistence behaviour have been developed within an African context and the applicability of such models to Pleistocene north-west Europe is questionable. Indiscriminate importation of African models to accommodate European data is inappropriate as African and European environments, both past and present, are distinctly different (Stopp, 1997). Climatic variation offered colonising populations different resources, which may have required different approaches to subsistence and survival than recorded in an African context (Binford, 1985). For example, the availability of plant resources within northern latitudes is seasonal, and underground tubers are less available than within an African environment, though even here there is still considerable variation (Priddle, 2004). The ability of hominin populations to identify edible plant resources within this new environment may have necessitated, at first perhaps, a heavier dependence on animal resources which are easily identifiable across space and time (Gamble, 1999).

In addition, many of the faunal assemblages in European localities have been recovered from the terraces of major European river systems, such as the Thames, Rhine, and Somme (Bridgland, 1994; Bridgland *et al.*, 2006; Gamble and Porr, 2005). Differences in assemblage accumulation and modification agents necessitate a more specific taphonomic methodology that can incorporate and investigate factors that may be unique to a European Pleistocene environment. Although the theoretical and methodological frameworks developed in Africa continue to be a useful tool for understanding and differentiating behaviour, such frameworks should be modified when considering European sites and assemblages (Gifford-Gonzalez, 1991). The next sections will focus more specifically on the evidence for hominin subsistence behaviour at a European scale and highlight considerable variability in behavioural interpretations.

2.3.1 Subsistence during the Lower Palaeolithic

The European Lower Palaeolithic is represented by a moderate number of open-air and cave sites (see Figure 2.1 and Figure 2.7). The discussion below is a brief introduction to the ongoing debate about early European hominin subsistence and some of the themes that will be dealt with in subsequent chapters.

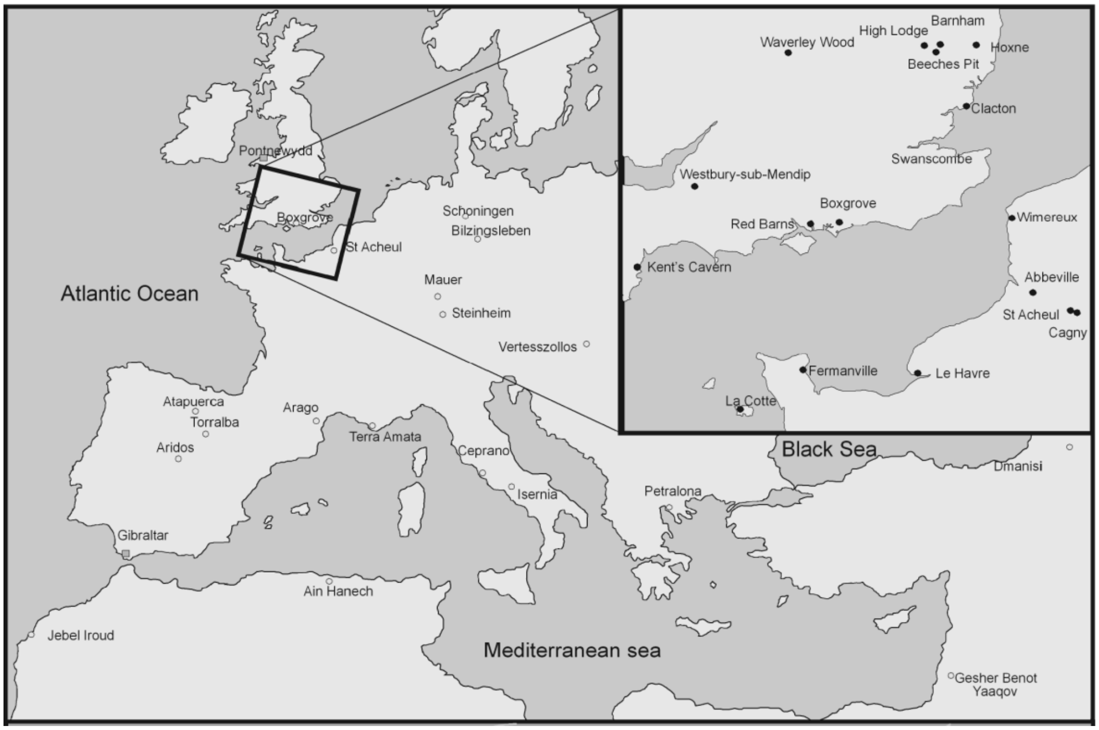


Figure 2.7 Principle Lower Palaeolithic sites in Europe with insert of British localities Modified from Pope (2002, Figure 3.1)

During the Lower Palaeolithic a major land bridge across the eastern English Channel allowed for the free access and movement of both animal and hominin populations into southern Britain (Preece, 1995). Britain was essentially the outermost peninsula of mainland Europe. Without the English Channel as a barrier it is possible that there was a constant transfer of both cultural and behavioural signatures. Therefore, any discussions of hominin behaviour should be compared at a broader European scale even though these sites are now isolated from mainland Europe (Gamble and Porr, 2005; Preece, 1995).

Investigations into the subsistence strategies of *H. heidelbergensis* at a European and UK scale have produced evidence for both active and passive subsistence behaviour. The key site of Boxgrove (c.485kya; see chapters 4 and 5 for more detail) has produced one of the largest Middle Pleistocene faunal assemblages from any site in the UK or mainland Europe, along with large quantities of exceptionally preserved bifaces and debitage material (Roberts and Parfitt, 1999a). The depositional conditions have provided unique conditions that allow for detailed reconstruction of hominin behaviour within this Pleistocene landscape (Pope and Roberts, 2005; Pope, 2002). Hominin bone surface modifications have been recorded across most large and medium sized animals including rhinoceros, deer and horse (See Chapter 5 and Roberts and Parfitt, 1999b). The location and intensity of these modifications combined with an absence of carnivore modifications suggests that these populations were holistically utilising these carcasses. Certain localities on site, such as the ‘horse butchery’ site (GTP 17), preserve evidence for isolated butchery events (Roberts and Parfitt, 1999b). When combined with evidence of a puncture wound on the horse scapula this data provides strong evidence for an active subsistence strategy possibly based on the hunting of large to medium-sized fauna (Chapter 5 and Roberts and Parfitt, 1999b). Excavations at the site of Ebbsfleet (400kya; UK) have recovered a single elephant carcass with similar evidence for *in situ* knapping and butchery of this carcass (Wenban-Smith *et al.*, 2006). Wenban-Smith *et al* are uncertain if such modification illustrates a planned hunting strategy or confrontational scavenging at a natural death but the evidence demonstrates that hominins had primary access to carcass resources.

Indirect evidence of possible hunting behaviour has also been found at the site of Schöningen (400kya; Germany) where several wooden spears have been recovered (Dennell, 1997; Thieme, 1997; Thieme, 2005; Voormolen, 2008). Analysis of these spears indicates that they have similar dimensions and weight distributions to modern day javelins, suggesting that they were thrown and possibly indicative of more active subsistence behaviour. The association of these implements with a modified faunal assemblage has been interpreted as evidence of hunting behaviour (Thieme, 2005; Voormolen, 2008). A similar wooden point from Clacton (UK) has been suggested as evidence of a similar implement although some authors believe they may have been multipurpose tools, even used as ‘snow probes’ to locate carcasses (Gamble, 1994; McNabb, 1989). However, experimental observations of similar wooden points (Smith, 2002; Smith, 2003b) have discovered ‘rifling marks’, caused by the spinning javelin point impacting on the bone. Similar ‘rifling marks’ have been identified on the Clacton point (*pers obsv*) perhaps suggesting use as a javelin. Boxgrove and Schöningen have provided a unique insight into the subsistence behaviour of *H. heidelbergensis*.

Sites that had previously been perceived as resulting from primary hominin accumulation, such as Torralba (Spain), Aridos (Spain), and Swanscombe (UK), were reassessed during the 1980s (Binford, 1985). Binford reassessed material from Waechter’s excavations (1968-

72) at Swanscombe (UK), which had previously been interpreted as evidence of a hunting camp alongside the river (Waechter, 1968). Binford highlighted hominin modification on longbone epiphyses as evidence for marginal scavenging from carcasses on the river margins (Binford, 1985). He also reanalysed the Spanish site of Torralba (400kya) where elephant remains had been recovered in river sediments that also contained lithic tools and had been interpreted as evidence of hominin carcass-processing (Binford, 1987b). Binford's analysis of natural modifications highlighted considerable trampling and destruction of elements and led the author to suggest that the elephant remains illustrated an attitional, natural death profile (Binford, 1987b). Binford used such evidence to suggest that hominin presence and use of the site was sporadic and not indicative of a planned hunting strategy.

Other sites have been recovered with evidence for lithic tools in association with large-medium-sized faunal remains, but the impact of hominin behaviour at these sites is inconclusive. At Ambrona (350kya; Spain) the excavation of elephant remains along with lithic tools has been interpreted as evidence of direct hominin accumulation, like other Iberian and European sites of a similar age (Freeman, 1975). Detailed reanalysis has highlighted that multiple factors were in operation throughout the duration of the site, with the loss of a large section of the site through post-depositional erosion and hydraulic action (Villa *et al.*, 2005). Villa *et al* (ibid) have highlighted evidence of hominin behaviour at the site but reject the association of lithic tools with faunal remains because of disturbance by hydraulic action. In addition, they could not determine the type of behaviour represented at the site but rejected Binford's notion of *ad hoc* scavenging from previous carnivore kills due to an absence of such modifications throughout the assemblage (Villa *et al.*, 2005). Lower Palaeolithic sites highlight considerable variation in subsistence behaviour with some sites illustrating evidence for apparent active behaviour whilst others indicate a more passive strategy. Binford's reassessment of numerous European localities, as part of his wider reassessment of hominin behaviour, led him to advocate that *heidelbergensis* was primarily a marginal scavenger (Binford, 1985, 1987b). Although undoubtedly some sites illustrate evidence for scavenging behaviour the degree to which this evidence represents a 'unified' strategy is debatable. In addition, evidence from other sites of this period suggests that such scavenging behaviour may represent isolated events within a broader subsistence framework, and not necessarily a separate strategy or hominin population.

2.3.2 Subsistence during the Middle Palaeolithic

Despite the richness of Middle Palaeolithic sites on the European continent (Maastrict-Belvadere, Wallertheim, La Borde, La Cotte de St Brelade, Neumark-Gröben) there is a relative absence of large-scale open-air sites in the British Isles (see Figure 2.1 and Figure 2.8), with most sites representing isolated find spots particularly within river terrace deposits (Gamble, 1999; White *et al.*, 2006).

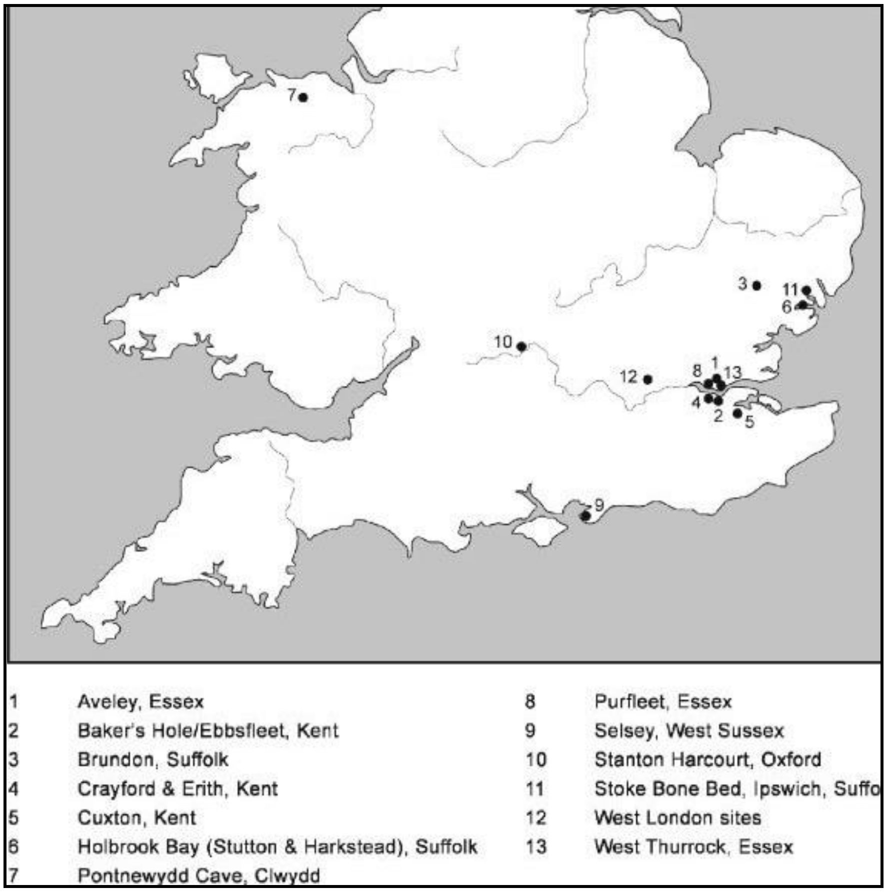


Figure 2.8 Location of early Middle Palaeolithic sites in Britain
Modified from White *et al* (2006, Figure 1)

Investigations into Middle Palaeolithic hominin subsistence have produced evidence similar to that detailed for the Lower Palaeolithic, with authors advocating for both active and passive subsistence behaviour (Gaudzinski, 1996). Faunal analysis at European sites has highlighted several different, and often competing, forms of Neanderthal subsistence behaviour:

1. Specialised monospecific hunting of medium-sized herd animals such as bison, horse and reindeer
2. Hunting of megafauna such as mammoth and woolly rhinoceros.

3. Obligate scavenging of carnivore kills and hunting of smaller prey.

Whether these subsistence strategies were practiced independently, or formed part of a more structured approach is unclear. Nevertheless, many authors have suggested that the presence of a limited number of species in the faunal assemblages at certain sites is an indication of specialised monospecific hunting (Farizy *et al.*, 1994; Gaudzinski, 1995, 1996, 1999; Mellars, 1996). The site of Wallertheim (110kya; Germany) contains deposits with large quantities of lithic and faunal material (Gaudzinski, 1996). Gaudzinski suggests that the high incidence of bison remains combined with hominin modification signatures are evidence of a focussed monospecific hunting strategy (Gaudzinski, 1996). Excavations at Mauran (58-71kya; France) have recovered similarly large quantities of lithic tools and bison remains (Farizy *et al.*, 1994). Farizy *et al* (ibid) have suggested that the modification signatures and skeletal profile pattern highlight a similar monospecific subsistence strategy to that suggested by Gaudzinski for Wallertheim (Gaudzinski, 1996). A similar pattern of monospecific hunting has been suggested for the faunal assemblage from La Borde (128-186kya; France) where lithic tools and bison remains have been excavated from Pleistocene deposits (Jaubert *et al.*, 1990).

There is an undoubted predominance of certain species from European Middle Palaeolithic sites but some authors have questioned whether this represents an actual pattern of single-species hunting (Conard, 1999). For instance, Conard (1999) undertook new excavations at Wallertheim to identify where in the stratigraphic sequence the majority of the faunal material had originally been recovered from. His analysis could not identify any horizon that demonstrated the richness observed in the original excavations. It is possible that the original excavation focussed more exclusively on larger, more identifiable specimens which may have produced a slightly skewed faunal assemblage. Conard's (1999) analysis of the faunal assemblage from this excavation indicates hominin exploitation of smaller quantities of animals from more than one species. The author's analysis does not support the idea of monospecific hunting at this location (Gaudzinski, 1996; 1999).

Other Middle Palaeolithic sites appear to highlight the targeting of certain megafaunal species. Excavations at the site of Lehringen (125kya; Germany) uncovered an elephant skeleton with a wooden spear apparently lodged in the rib cage, perhaps providing some of the clearest evidence of megafaunal hunting (Movius, 1950). Supporting evidence comes from the site of La Cotte de St Brelade (250kya; Jersey) where extensive mammoth and woolly rhino remains were excavated from the base of a cliff (Scott, 1980). Interspersed amongst these faunal remains were lithic tools and Scott has suggested that the faunal arrangements suggests that material has been sorted (ibid). The author has suggested that the site represents evidence of Neanderthal populations driving megafauna off the promontory before processing their carcasses (Scott, 1980). Similarly, Gaudzinski has highlighted the presence of lithic tools and large to medium-sized fauna at the German sites of Neumark-Nord and Gröbern (Gaudzinski, 2004; Mania *et al.*, 1990). The limited presence of predator-scavenger modification on these carcasses has been used to suggest that hominins had primary access to these carcasses either through active hunting or confrontational scavenging at predator kills or natural deaths (Gaudzinski, 2004).

The late Middle Palaeolithic site at Lynford (64-67kya; UK) contains deposits dominated by mammoth remains and associated lithic remains. Schreve (2006) has suggested that the absence of mammoth long bones may represents the butchery and removal of these meat bearing elements from the site. In addition, she has highlighted the high incidence of pathologies on various skeletal elements as evidence for failed hominin hunting attempts (Schreve, 2006). Although there are numerous Middle Palaeolithic sites associated with megafaunal remains some authors are sceptical as to whether this indicates that Neanderthals specifically targeted these species (see for example Burke, 2004). Nevertheless, the apparent ability for earlier populations to hunt and process such large animals suggests that Neanderthals must also have possessed such capabilities. Indeed, the high incidence of healed fractures and injuries recorded across many Neanderthal skeletons certainly suggests a subsistence behaviour that required prey to be dispatched at close quarters (Stringer and Gamble, 1993).

As documented during the Lower Palaeolithic some authors have highlighted evidence for Neanderthal scavenging from carnivore kills and hunting of smaller prey (Stiner, 1994). Stiner’s work has focussed exclusively on Italian cave sites and she studied museum collections to assess Neanderthal subsistence at a regional scale. However, her approach has received criticism as it has been suggested that the collections she used are biased by the absence of shaft fragments which were not collected in the original excavations (Marean, 1998). Marean (1999) has suggested that the skeletal element representation has been artificially deflated and the absence of shaft fragments makes disarticulation look more common-place than meat removal. In addition, he has argued that the presence of both carnivore and hominin modification signatures on elements need not only indicate hominin scavenging.

2.3.3 Summary

Research into hominin subsistence has undergone significant theoretical and methodological shifts throughout the 20th century. The presence of lithic tools in deposits containing faunal remains is no longer sufficient evidence of a cultural accumulation though it does provide a degree of "cultural credence" (Stopp, 1997 p4). Despite improved methodological frameworks there is still fierce debate surrounding the subsistence behaviour of Palaeolithic hominins at a global scale. Neither hunting nor scavenging has been disproved as a viable method of subsistence, though the polarisation of opinion has been reduced considerably compared to debates during the 1980s about hominin subsistence behaviour (Stanford, 1999). Rather than viewing Palaeolithic sites within the restrictive hunting/scavenging scheme, it is perhaps better to consider that hunting and scavenging were not necessarily practiced independently of each other. From a survival perspective a hunter is unlikely to pass up the opportunity of a 'free meal'; arguably choice is a modern construct. Although less polarised than before, Palaeolithic archaeology still appears constrained by an almost Victorian ideal of progress; from primitive 'scavenging' to a more structured 'hunting'. Such food-procurement strategies need not represent different groups with different subsistence activities but rather a continuum. Nevertheless, hominin behaviour appears to represent one of a number of bone modification agents and to fully understand the role and importance of hominins in site formation it is vital to understand the role and importance of other site formation processes.

2.4 Bones are not enough: The case for cultural causality

Hominin behaviour represents one of numerous potential agents of faunal accumulation and modification. The presence of both lithic tools and modified fauna is no longer perceived as a strong indicator of past hominin meat-procurement behaviour. The previous discussion has highlighted how taphonomic and analogue studies have helped distinguish hominin behavioural signatures from natural ‘background’ signatures. The desire to distinguish and define hominin behaviour as a suite has existed since Dart first defined his “osteodontokeratic culture” (Dart, 1959). At present, hominin involvement with an animal carcass can be readily identified by the presence of specific bone surface modification such as cut marks or deliberate fracturing. Similarly, natural modifications such as predator-scavenger gnawing or hydraulic rounding are also readily definable and identifiable. However, what is required is to understand the role of all these modification agents, both hominin and natural, within a specific framework that allows for “…bridging arguments between our objects of study and the relationships which we wish to know…”. (Gifford-Gonzalez, 1991 p228).

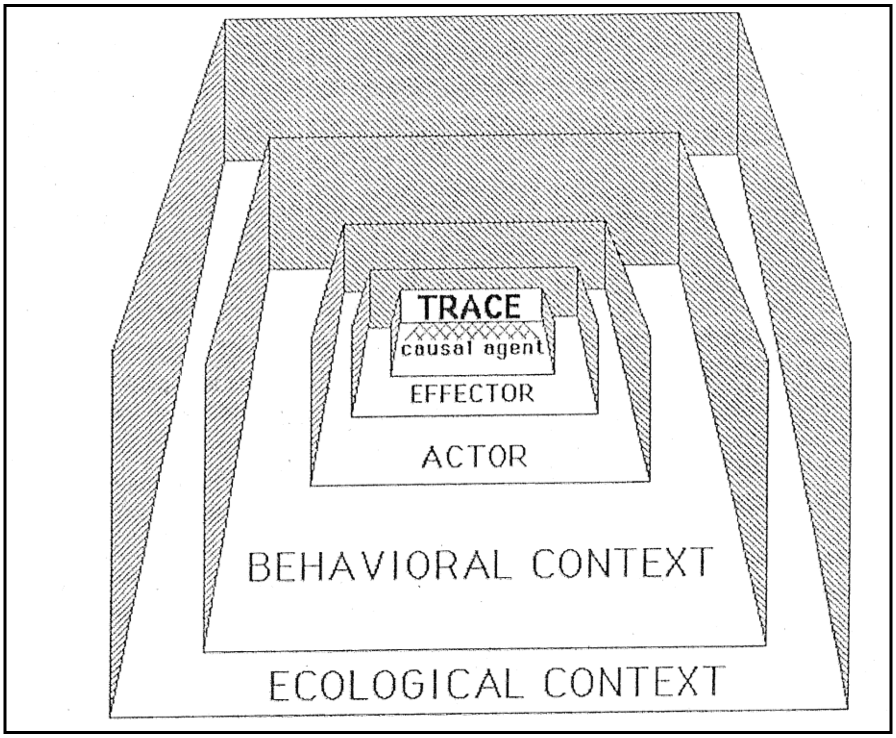


Figure 2.9- Nested system of analytical reasoning
By linking a trace to a specific agent and situating this within the behavioural and ecological contexts, Gifford-Gonzalez (1991, Figure 2)

The identification of a particular modification, or ‘trace’, has been thoroughly studied and can be traced back to a particular causal agent or ‘actor’ through comparative actualistic work (Gifford-Gonzalez, 1991). The ‘behavioural context’ is a conceptual framework created through the interpretation of various modification signatures (see Figure 2.9). However, at present the identification of such universal modification signatures appear to carry similar behavioural meanings within and between different environmental contexts (see Sections 2.2 and Sections 2.3). Nevertheless, an investigation into the palaeoecological context inhabited by these Palaeolithic actors may help researchers to understand how the behaviour of non-hominin actors could have influenced hominin subsistence and adaptation behaviour.

Despite improved theoretical and methodological frameworks the association of lithics with modified fauna is still considered evidence of hominin involvement with a faunal assemblage without necessarily considering the site specific context, depositional environment and the time scale of artefact deposition (Bailey, 1983, 2007; Vaquero, 2008). The presence of lithic tools and faunal remains "neither justifies nor suggests any causal connection between the two artefact classes" (Stopp, 1997 p4). Marshall stated even in 1989 that

> *"…the close spatial association of stone artefacts and broken fossilised bones* is no *longer…good evidence that hominids were the primary agents of site formation."* (Marshall, 1989, p7)

Nevertheless, such "associations" remain, albeit implicitly, the foundation for models about hominin subsistence despite the fact that both may be incidental and unrelated. The "…presence of lithics with bones provides a degree of cultural credence" (Stopp, 1997, p4). However, the presence of such artefacts does not implicitly suggest evidence for hominin hunting or even interaction with these mammalian species (ibid). The presence of Pleistocene localities within riparian and lacustrine environments perhaps indicates the focal nature of these sites for all animal species including hominins. The recovered faunal remains could represent the natural accumulation of bones at these locations without any hominin involvement (Conybeare and Haynes, 1984; Fernadez-Jalvo and Andrews, 2003; Haynes, 1988a, 1988b; Stopp, 1997; Voorhies, 1969). To understand the role of hominin behaviour at open-air Pleistocene localities requires a more detailed understanding of other site formation processes. For instance, many Pleistocene sites are located alongside past river channels; the changeable nature of river catchments at a seasonal scale and as a result of geomorphological processes throughout the Pleistocene could mean that any lithic and faunal material has undergone significant taphonomic transformation and could merely represent a secondary deposit unrelated to hominin behaviour (Isaac, 1983; Isaac and Crader, 1981; Stopp, 1997). More emphasis must be placed on the need to contextualise faunal analysis within a site specific framework to assess the role of all factors of faunal accumulation and modification (Dominguez-Rodrigo, 2002; Gifford-Gonzalez, 1989a, 1991; Isaac, 1983). Bones themselves, it seems, are no longer enough.

> *"…Faunal analysts…[tend] to rely solely on osteological evidence for inferences about hominid subsistence behaviour…must now be revised to include other types of information…amenable to relational analogy- botanical, geological, artifactual, site structural, site locational and others…"* (Gifford-Gonzalez, 1991 p245)

Primary zooarchaeological analysis, regardless of geographical location, should employ an explicit taphonomic methodology. The presence of lithic and faunal remains within deposits does not necessarily indicate a direct association or evidence for hominin accumulation and modification. Gifford-Gonzalez's (1991) paper calls for a 'contextual approach' which synthesises primary faunal data with background contextual data. Such an approach requires a methodology that will identify and rigorously analyse *all* taphonomic agencies of faunal modification (Stiner, 1994). Archaeofaunas, or any artefacts, are not deposited within a vacuum, and survival depends upon both the palaeoecological and depositional environments, both of which can have serious impacts upon the survival of skeletal elements and behavioural signatures. By assuming a cultural genesis for the faunal assemblage we may "…overlook the effect of attritional processes on ancient assemblages…" (Stopp, 1997). Additionally, the primary data should be "contextualised" with data that considers the behavioural ecology for both predator and prey species identified at the site. A consideration of how such species may have behaved within a palaeoecological context would allow for an assessment of the available subsistence opportunities and potential interactions between hominins and other species. A multi-faceted approach is required to identify, distinguish and discount all other agents of modification before considering the assemblage as evidence of past hominin subsistence behaviour.

2.5 Site formation scenarios

In Chapter 1 the three major aims of this project were outlined:

1. **What taphonomic agents and site formation processes were responsible for the formation and modification of each faunal assemblage?**
2. **Is there sufficient evidence to discuss hominin meat-procurement behaviour at each study site?**
3. **Are these hominin meat-procurement strategies similar to those previously proposed?**

These aims can be combined into a number of alternative scenarios that can then be used to test the nature and importance of hominin behaviour in the accumulation of faunal assemblages at British Lower and Middle Palaeolithic sites. To achieve these aims a holistic approach is required to assess all agents of faunal accumulation, before contextualising this information with data on the site-specific palaeoenvironment and depositional conditions. Once all of these taphonomic agents have been assessed I will consider the data within the framework of several scenarios regarding site and assemblage formation. The scenarios that I have formulated are a result of an extensive literature review, and represent ongoing and often conflicting debates within research into hominin subsistence behaviour.

Scenario 1

The hominin scenario states that the accumulation of faunal remains on site was a direct result of hominin subsistence behaviour.

This scenario is based on the idea that the lithic tools and faunal remains from Pleistocene deposits are directly associated and represent evidence of past hominin subsistence behaviour (Dominguez-Rodrigo, 2002). Modification signatures should indicate primary access to the meatiest regions of the skeleton such as the upper limb bones (Dominguez-Rodrigo, 1999a, 2003b). Hominin modification signatures should be numerous and be distributed across most elements and species. Conversely predator-scavenger modification signatures should be relatively low in density, indicating secondary access, and confined to regions with limited meat such as the longbone epiphyses and skeletal extremities. Where both modification signatures are present on skeletal elements, then predator-scavenger modification should overlie hominin modification (Binford, 1981).

Scenario 2

The predator-scavenger scenario states that the accumulation of faunal remains on site was a direct result of predator-scavenger subsistence behaviour.

The predator-scavenger scenario was first discussed by Binford (1985) and he suggested that faunal assemblages at Palaeolithic sites represented evidence for past predator-scavenger activity. This model is in complete contradiction of the hominin scenario. Predator-scavenger modification should be numerous and be distributed across most elements and species. Modification signatures should indicate primary access to the meatiest regions of the bones whilst any hominin modification should overlie predator-scavenger signatures and be confined to regions with limited meat (Binford, 1981). This scenario will also assess Selvaggio's (1998b; 1998c) three stage model to see whether there is any evidence for competition and multiple use and re-use of carcass resources by both species.

Scenario 3

The catastrophic scenario states that the faunal remains on site have accumulated as a result of a mass death event.

This scenario is a result of research undertaken by Conybeare and Haynes (1984) that looked at the study of mortality profiles caused by mass death events such as flash floods. Faunal assemblages caused as a result of such events should contain a wide variety of species that essentially constitute the living population at the point of the mass death event. In addition, there should be variation in the age and sex structure of the faunal assemblage with a representation of considerable numbers of prime aged individuals along with older and more juvenile specimens. Although it would be expected that terrestrial weathering would indicate a similar duration of exposure, Haynes has highlighted that this varies considerably at such sites (Haynes, 1988b). This could relate to certain carcasses remaining covered by flood waters or re-exposed by hungry predators, both of which would produce varied terrestrial weathering patterns. Haynes has noted that the large quantities of meat available as a result of these events means that predator-scavengers do not feed intensively on each carcass as there are plenty available (Haynes, 1988b). Therefore it is possible that the density of both hominin and predator-scavenger modification may be considerably lower or even invisible.

Scenario 4

The attritional scenario states that the faunal assemblage represents the gradual, natural deaths of animals.

This scenario represents the accumulation of faunal remains at these study sites through the natural deaths of animals, and is the opposite of the catastrophic scenario (Conybeare and Haynes, 1984). The faunal assemblages from natural deaths should illustrate a more restrictive age and sex mortality profile than that illustrated in scenario 3. The age structure should be represented by older and more juvenile individuals with an absence of prime aged animals. Similarly there should be an approximately equal distribution of male and female individuals represented within the faunal assemblage. Terrestrial weathering should indicate differential exposure of individuals highlighting a consistent input of faunal material over a longer time period (Conybeare and Haynes, 1984). Predator-scavenger and hominin modification may overlap at these locations, compared to mass death sites, as the availability of resources is more limited.

Scenario 5

The secondary deposit scenario states that the faunal accumulation represents a derived assemblage.

The final scenario was initially suggested by Isaac (1983; Isaac and Crader, 1981) and states that faunal material has been transported to the site by natural processes, notably rivers, and deposited in a derived context (Stopp, 1997; Voorhies, 1969). If active transportation of faunal material was undertaken, the long axis orientation of specimens should be aligned in the direction of current flow. The transportability of certain faunal elements within river channels varies considerably and consequently provides considerable patterning in faunal assemblages. Denser elements (e.g. teeth) are less transportable and are normally laid down in lag deposits whilst lighter elements (e.g. vertebra) are more likely to be eroded or transported off-site. The hydraulic rounding on the edges of specimens is further indication of sustained exposure and transport within a riparian environment. Although secondary deposits of faunal remains might exhibit evidence of hominin and predator-scavenger behavioural modification, this relates to events that occurred elsewhere and cannot necessarily provide information about subsistence behaviour on or around the site locale.

An extensive literature review has highlighted numerous agents that can influence assemblage formation and modification and it is possible that no one agent is solely responsible for the accumulation and modification of the faunal assemblages from each study site. This could be because each of the factors had a role in influencing faunal accumulation at each of the study sites. The scenarios detailed above were developed as a result of a detailed literature review but do not necessarily represent all agent(s) of faunal accumulation and modification.

2.6 Summary

This chapter has provided a review of the ongoing debates regarding early hominin subsistence. Current behavioural models indicate that both active and passive subsistence strategies were undertaken simultaneously. Current evidence does not disprove either model but rather suggests that both may represent part of a wider behavioural and subsistence framework. There has been significant progress in the identification of specific agents of modification and their corresponding signatures in modern analogue assemblages and in the archaeological record. Nevertheless, previous research has highlighted that hominins are one of numerous agents that can accumulate and modify faunal assemblages. Therefore, to fully understand the role of hominins in faunal assemblage accumulation it is vital to consider such behaviour within a detailed palaeoenvironemntal context. Considering and discounting all other agents of assemblage formation provides greater confidence in assigning hominin behaviour as a factor in faunal assemblage accumulation. The subsequent chapter will provide a more detailed description of the methodology and terminology used throughout this study, and also comprehensive contextual information about each of the study sites in order to establish a framework within which to analyse and discuss the primary zooarchaeological data.

Chapter 3 Methodology

3.1 Introduction

The previous literature review has shown that interpretations of hominin subsistence behaviour during the Lower and Middle Palaeolithic have shifted considerably in the last 40 years. This reanalysis has produced two hypotheses concerned with the procurement strategy and contribution of animal protein to early hominin diet. Both views have been supported by the analysis of faunal assemblages from numerous sites, for example Boxgrove; Schoningen; Toralba; and Wallertheim. Frequently, the same assemblages have been analysed by other researchers and produced different behavioural interpretations, for example Swanscombe (Binford, 1985; Waechter, 1976).

Faunal analysts have traditionally used two techniques to approach the study of hominin subsistence; skeletal profile analysis and detailed studies of bone surface modification. Dominguez-Rodrigo has discussed the problems of using skeletal part profiles as evidence for hominin subsistence and faunal accumulation (Dominguez-Rodrigo, 2002). This technique often uses comparisons with the patterns of skeletal disarticulation, butchery and transport within modern hunter-gatherer groups (Dominguez-Rodrigo, 2003b; Lupo and O'Connell, 2002; O'Connell *et al.*, 2002a; O'Connell *et al.*, 2002b). Such an approach can highlight the effect of hominin butchery practices on carcasses, but the nature of archaeological sites means that several agents such as flowing water; predator-scavengers; or weathering could be responsible for the formation of the observed skeletal profile (Behrensmeyer, 1978, 1987; Behrensmeyer and Hill, 1980; Bonnichsen and Sorg, 1989; Conard and Dennell, 1995; Dominguez-Rodrigo, 2002; Fernadez-Jalvo and Andrews, 2003; Lyman, 1994; Turner, 1989). In addition, the relative density of the skeletal elements can result in the differential destruction/preservation of certain elements and portions, entirely unrelated to hominin involvement.

The drawbacks of skeletal element representation has meant that the detailed study of surface modifications has "…assumed fundamental importance in zooarchaeological analyses of vertebrate remains…" (Fisher, 1995, p7) and studies of hominin subsistence

(Binford, 1981; Bunn, 1981, 1983; Dominguez-Rodrigo, 2002; Roberts and Parfitt, 1999b). Fisher has noted the importance of bone surface modifications in tracing the antiquity of meat eating and use of animal carcasses at different times and places throughout human evolution (Fisher, 1995). Since the initial identification of hominin cut marks numerous authors have highlighted non-human taphonomic process that can sometimes mimic genuine cut marks and other hominin modification (Behrensmeyer, 1987; Blumenschine *et al.*, 1996; Haynes, 1988a; Olsen and Shipman, 1988; Potts and Shipman, 1981; Selvaggio, 1994).

Both zooarchaeological approaches used to study hominin subsistence have advantages and drawbacks and both are constrained by the use of different methodologies to record element, portion and location of modification (Dominguez-Rodrigo, 1999a, 2002, 2003a, 2003b; O'Connell *et al.*, 2003; O'Connell and Lupo, 2003). Neither approach should be used in isolation to study the importance of hominins in site formation. Archaeologists have acknowledged that to reliably reconstruct past hominin activities a detailed assessment of non-human taphonomic processes that contributed to site formation is required (Binford, 1981; Fisher, 1995; Gifford-Gonzalez, 1989a, 1991). Hominins formed part of the palaeocommunity at these sites and it is essential to consider them as one of a number of taphonomic processes operating on a faunal assemblage (Gifford-Gonzalez, 1991; Stiner, 1994). For a more accurate understanding of hominin involvement with faunal assemblages from Palaeolithic sites, it is necessary to utilise all available sources of data. Whilst Dominguez-Rodrigo has made valid arguments for the exclusion of skeletal profiles from discussion of hominin subsistence, the use of these profiles can provide indicators of assemblage fragmentation and destruction (Dominguez-Rodrigo, 2002). This research found that combining body part representation data with information from a detailed bone surface modification (BSM) analysis helped explain the fragmentation patterns observed. Reconstruction of the site palaeonenvironment and the depositional conditions provided a contextual framework for the faunal remains which helped to explain patterns highlighted during faunal analysis (see Chapters 5-8) (Gifford-Gonzalez, 1991). Finally, combining both types of data with an analysis of predator and prey behavioural ecology helped assess competition and conflict for resources within the site palaeoenvironment.

3.2 Database construction

The broad aims of this thesis was to assess which site formation processes were responsible for the accumulation of faunal assemblages at several key UK sites and determine the role, if any, hominins played in accumulation. These study sites (Boxgrove, Swanscombe, Hoxne, Lynford) were well excavated and possess some of the largest collections of faunal material recovered from any Lower and Middle Palaeolithic localities in the UK. Importantly, previous analysis of faunal assemblages from these sites has been used to support either an active or passive role for hominins in faunal accumulation, and in some cases both. The faunal material for Boxgrove, Swanscombe and Hoxne is stored at the Palaeontology Department, Natural History Museum (London). The Lynford material is stored at Norfolk Archaeology Unit.

3.2.1 Creating the database

The discovery of Palaeolithic sites across the globe has led to the development of different types of recording methodologies, centred on a ‘tradition’ of site based analysis (see for example Binford, 1981, 1984; Dominguez-Rodrigo, 1999a, 2002, 2003b; Parfitt, 1999a; Popkin, 2005; Schreve, 1996; Stopp, 1993, 1997). Such variation has inevitably caused debate about which methods are best to use in order to record and understand past hominin subsistence behaviour. It is essential, therefore, that any methodology used can be easily replicated and consistently repeated to allow for comparison within and between sites (Dominguez-Rodrigo, 2002).

Personal experience of a descriptive database (Smith, 2003a) found considerable variation was produced in the analysis stage. Thus for this thesis, in order to reduce variability in data collection, I constructed a relational database, using Microsoft Access, with predefined categories for species, element and BSM (see Harland *et al.*, 2002; Popkin, 2005). The database used a visual component (see section 3.2) to record element, portion and modification and reduced the descriptive nature of the recording methodology. The database was constructed around a main form that provided a path to other forms where more detailed information about element, portion, bone fracturing and location of surface modification could be recorded. The database had a “one to many” relationship that allowed one record in the main form to have more than one record in each secondary form.

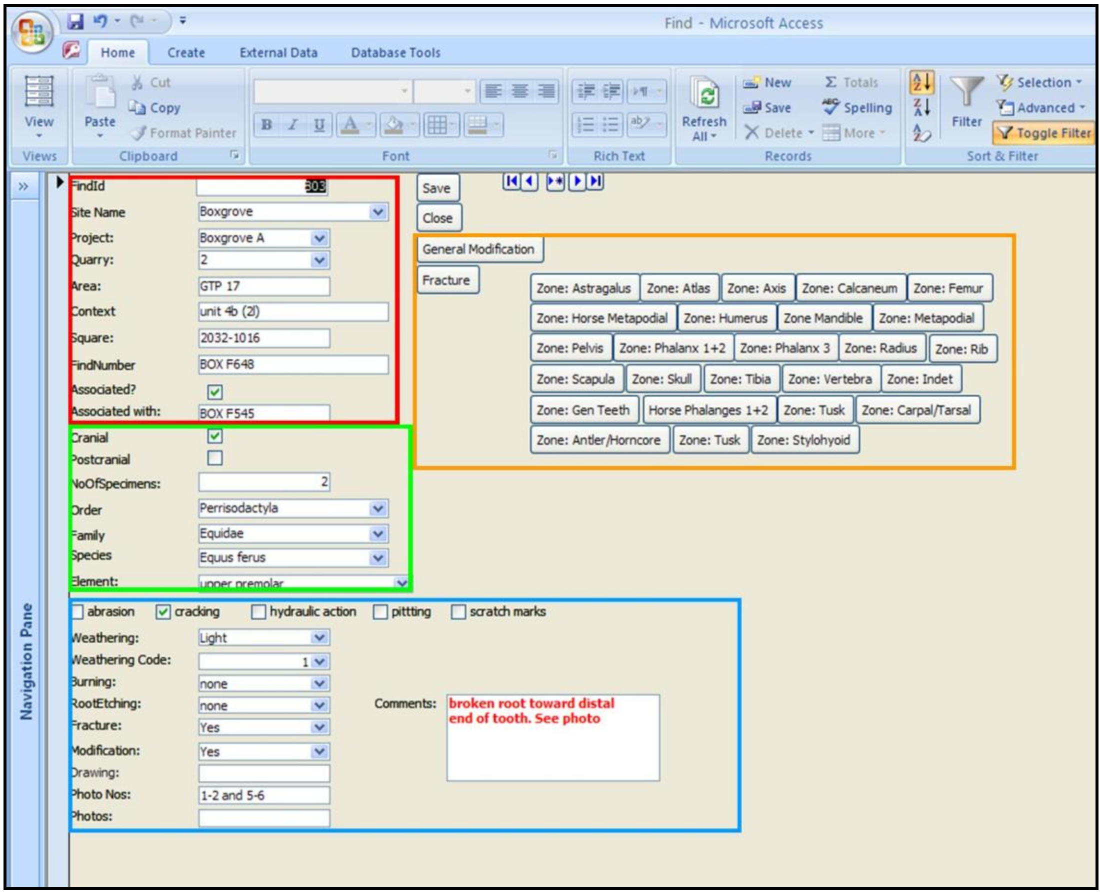
This database relationship proved particularly useful when recording multiple, unrelated specimens or large quantities of BSM. The data terms were input into "code" tables prior to data collection which ensured a consistency of recording and allowed for greater intra and inter-site comparisons. Although the structure and categories were predefined there was sufficient flexibility to allow for the addition and removal of recording categories throughout the data collection process. The following sections review the categories and data fields used throughout primary data collection along with the information used to provide the contextual framework discussed above (Gifford-Gonzalez, 1991).

3.3 Data collection

As mentioned above, the categories and fields used for data collection were based on previous research using the Swanscombe faunal assemblage and also through a review of the literature for each study site (Conway *et al.*, 1996; Roberts and Parfitt, 1999a; Schreve, in press; Singer *et al.*, 1993) and other faunal databases (Harland *et al.*, 2002; Meadow, 1978; Popkin, 2005). All material was studied using an oblique light source and low-powered microscope as required. The use of high powered Scanning Electron Microscopy was considered but as Blumenschine *et al.* demonstrated, using blind tests, distinguishing between cut marks and other 'scratch marks' is not necessarily made any easier by high powered microscopy (Blumenschine *et al.*, 1996). The following sections provide further detail about fields used, discuss the reasons behind their inclusion in this database, and, finally, evaluate the usefulness of particular categories.

3.3.1 Site data

Previous sections (see Chapter 2 and Section 3.2) have discussed the need to fully account for all agents of site formation through the use of data from both primary faunal analysis and site contextual information. In order to understand the complex formation processes operating at each of the study sites the first section of the database recorded basic site data (see Figure 3.1 and Table 3.1). It was important to integrate such information within the database to allow for a more detailed analysis of faunal material distribution throughout the stratigraphic sequence and, where possible, spatially across the site. Such information also allowed for a similarly detailed contextual analysis of BSM.



FindId: 303
Site Name: Boxgrove
Project: Boxgrove A
Quarry: 2
Area: GTP 17
Context: unit 4b (2l)
Square: 2032-1016
FindNumber: BOX F648
Associated? ☑
Associated with: BOX F545
Cranial ☑
Postcranial ☐
NoOfSpecimens: 2
Order: Perrisodactyla
Family: Equidae
Species: Equus ferus
Element: upper premolar

☐ abrasion ☑ cracking ☐ hydraulic action ☐ pittting ☐ scratch marks
Weathering: Light
Weathering Code: 1
Burning: none
RootEtching: none
Fracture: Yes
Modification: Yes
Drawing:
Photo Nos: 1-2 and 5-6
Photos:
Comments: broken root toward distal end of tooth. See photo

Figure 3.1 Layout of main 'Find' form
Coloured squares relate to different aspects of recording methodology: red box- basic site contextual data; green box- species and element data; blue box- natural taphonomy; orange box- links to other forms for detailed information on element preservation and predator-scavenger/hominin modification

Field	Description
Site Name	Name of site
Project	Name of project during which faunal material found
Quarry	Which quarry material recovered from (only applicable to Boxgrove)
Area	Specific trench/test pit where specimen recovered (e.g. GTP 17)
Context	The stratigraphic horizon the specimen was recovered from
Square	Site subdivision within trenches/test pits
Find Number	Specimen Find Number. Prefixed with 3 letter synonym to denote site: BOX (Boxgrove), SWN (Swanscombe), HXN (Hoxne), LYN (Lynford)
Associated	Denotes whether the specimen was associated with another find number

Table 3.1 Contextual data recorded on main 'Find' form for each specimen

There was considerable variation within and between the sites in relation to the quantity of contextual information recorded. For example, the Project, Quarry, Area, and Square fields were only really utilised for the most recently excavated assemblages from Boxgrove and Lynford, where the level of recording was much more detailed. Nevertheless the fields provided enough basic contextual information to analyse the faunal distribution and patterns of bone survival and modification within and between each site. In addition, such basic information could then be synthesised with more detailed contextual information from site reports to provide further information on site and assemblage formation.

3.3.2 Species, element and bone portion

Number of individual specimens

The inclusion of a "Number of Specimens" field was crucial for calculating the Number of Individual Specimens (NISPs) counts for each site and species (See Chapters 5-8). These counts were essential in order to generate the Minimum Number of Elements (MNEs) and Minimum Number of Individuals (MNIs) and thus, assess the degree of faunal assemblage fragmentation. Where there was evidence for fracturing and fragmentation of a specimen, the bone edge was studied to assess whether this phenomenon represented an older or more modern break. The latter could usually be confirmed if the bone edge was brighter, often whiter, than the surrounding bone. If the specimen exhibited a modern break it was refitted and recorded as a single specimen. However, if the break was older and hence related to site and assemblage formation, then this was recorded as two specimens.

Species

The next section on the main form (see Figure 3.1) recorded specific information on species, element and bone portion. For each specimen the Order, Family and Species was recorded. The identifications used were those recorded by previous authors (Parfitt, 1999a; Schreve, 1996, 2004b, 2006, in press; Stopp, 1993; Stuart *et al.*, 1993) and although most of the material had already been assigned to both species and element, the material was constantly assessed and if necessary reclassified.

Previous discussion (Chapter 2) demonstrated the occurrence of predator-scavenger and hominin modification on large/medium-sized faunal remains from Lower and Middle Palaeolithic sites. The location and distribution of this modification has proved pivotal to understanding the importance of both agents in site formation and the timing of access for both groups (see for example Dominguez-Rodrigo, 2002; Gaudzinski, 1996; Roberts and Parfitt, 1999a; Schreve, 2006). Therefore, the large/medium fauna (elephants, rhinos, bovids, equid and cervids) at each of the study sites formed the focus of primary data collection for this study (see Table 3.2), as these remains are most likely to preserve evidence for hominin modification and/or competition with other predator-scavenger species. In addition, these species have been previously analysed by other authors and used to support either active or passive hominin subsistence at a site (See Chapter 2 and Chapter 7; Binford, 1985; Waechter, 1976). Therefore, these assemblages were reassessed using the holistic methodology detailed below to determine the role and importance of hominins in assemblage formation and to assess whether the reanalysis undertaken for this thesis supported previous interpretations of hominin behaviour at these sites.

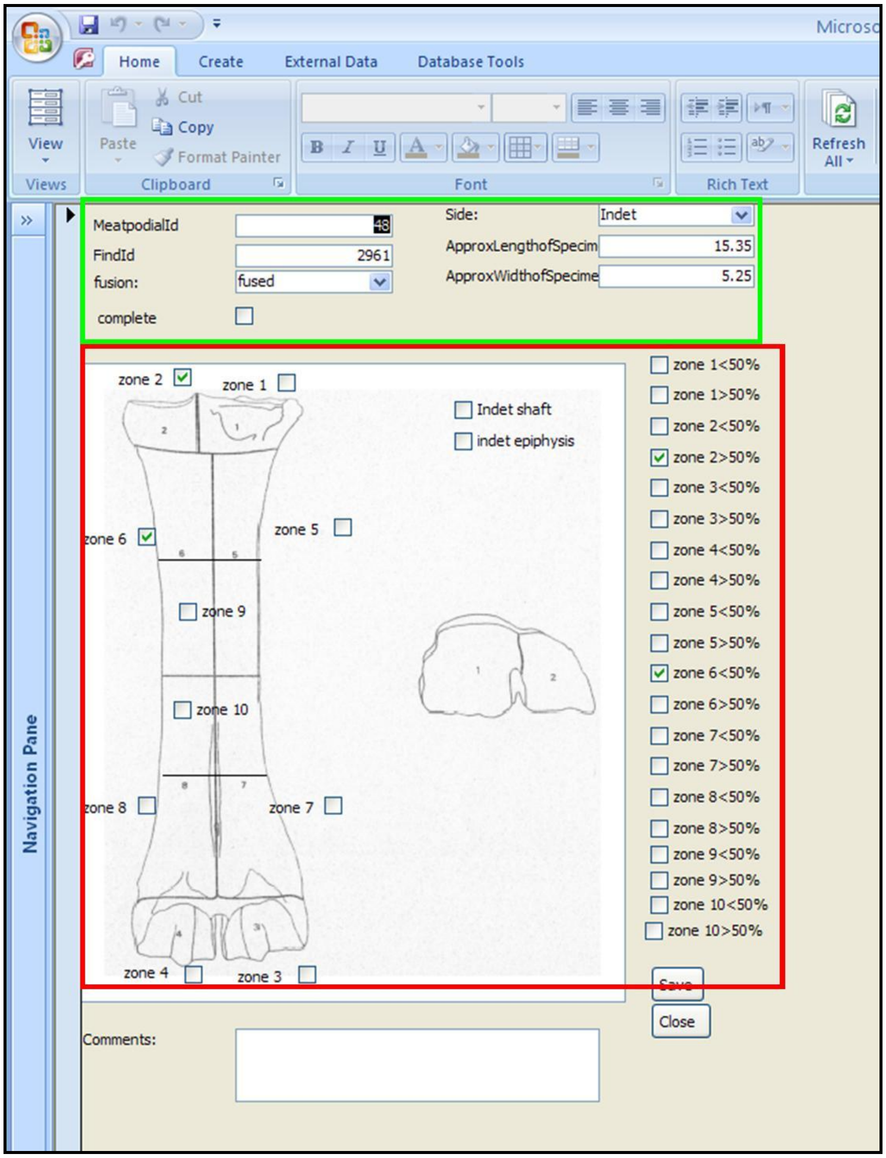
Species	Common Name
Mammuthus primigenius	Mammoth
Palaeoloxodon antiquus	Straight tusked elephant
Coelodonta antiquitatis	Woolly rhinoceros
Stephanorhinus kirchbergensis	Extinct rhinoceros
Stephanorhinus hemitoechus	Extinct rhinoceros
Stephanorhinus hundsheimensis	Extinct rhinoceros
Megaloceros verticornis	Extinct giant deer
Megaloceros giganteus	Extinct giant deer
Megaloceros dawkinsi	Extinct giant deer
Bison priscus	Bison
Bos primigenius	Extinct wild cow
Equus ferus	Horse
Cervus elaphus	Red deer
Dama dama	Fallow deer
Rangifer tarandus	Reindeer
Capreolus capreolus	Roe deer

Table 3.2 Large/medium-sized species recorded during analysis

Sometimes it was impossible to make a species determination because of an absence of diagnostic element features for comparison with, although it was possible to assign such specimens to a particular family. In such cases the specimen was assigned to the 'species indeterminate' category and abbreviated in the database to "*sp. indet*", for example Cervidae sp. indet. When neither a firm species nor family determination could be made a specimen was assigned a more general category, based largely on fragment size. The size groups used were: cattle/horse sized; deer/horse sized; giant deer sized; deer sized; red deer sized; fallow deer sized; large mammal. When none of these hierarchical inferences could be made the specimen was recorded as indeterminate, and abbreviated to "*indet*" in the database.

Element

Once site contextual and basic species and element data had been recorded, the database linked to sub-forms where more detailed information about a specific element could be recorded (see Figure 3.2). As discussed in the introduction to this chapter (see Section 3.1), numerous methodologies have been used to record element and portion survival which, in part, has contributed to the current controversy surrounding hominin subsistence (see particularly Dominguez-Rodrigo, 2002). Additionally, past experience with the Swanscombe fauna (Smith, 2003a), had illustrated that a more structured and less descriptive system was required to more accurately identify the preserved bone portion and also allow this recording system to be replicated at other sites .



MeatpodialId 48
FindId 2961
fusion: fused
complete ☐
Side: Indet
ApproxLengthofSpecim 15.35
ApproxWidthofSpecime 5.25

zone 2 ☑
zone 1 ☐
☐ Indet shaft
☐ indet epiphysis
one 6 ☑
zone 5 ☐
☐ zone 9
☐ zone 10
one 8 ☐
zone 7 ☐
zone 4 ☐
zone 3 ☐

☐ zone 1<50%
☐ zone 1>50%
☐ zone 2<50%
☑ zone 2>50%
☐ zone 3<50%
☐ zone 3>50%
☐ zone 4<50%
☐ zone 4>50%
☐ zone 5<50%
☐ zone 5>50%
☑ zone 6<50%
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☐ zone 7<50%
☐ zone 7>50%
☐ zone 8<50%
☐ zone 8>50%
☐ zone 9<50%
☐ zone 9>50%
☐ zone 10<50%
☐ zone 10>50%

Comments:

Figure 3.2 'Zone: Metapodial' form for recording detailed information about element portion survival Green box- fields to record information on fusion, element side and specimen length and width; red box- location of pre-defined zones with completeness categories for each zone.

Many different methods have been used to record bone portion (Dominguez-Rodrigo, 1999a, 2002, 2003b), and after an extensive literature review, I decided to employ a zonal system. Several notable methodologies have utilised a zonal system to record bone portion (Dobney and Rielly, 1988; Harland *et al.*, 2002; Popkin, 2005), and a similar scheme was used throughout this project to provide a more accurate method of identifying bone portion survival and illustrate the location of bone surface modification(see later section 3.3.4). The scheme was based on that proposed by Dobney and Rielly (1988) with some modifications involving the expansion of zones and the creation of new ones, to further distinguish between bone portion (see Appendix 1 for more detail). Pre-defined zones did not require constant description for each specimen and allowed for a consistency and comparability in recording terminology. Furthermore, a unified scheme facilitated easier comparisons within and between species and sites. As each zone corresponds to a specific location on each bone this allowed for direct comparison of bone survival within and between species along with information on the presence and location of modification (see section 3.3.4).

Despite using a zonal system, which improved the accuracy of recording bone portion, there was still the problem of defining the limits of specific bone regions such as proximal epiphysis, midshaft etc. This subject has been approached by numerous authors within the literature in an attempt to find some consensus (Blumenschine *et al.*, 1994; Blumenschine and Madrigal, 1993; Bunn and Kroll, 1986; Dominguez-Rodrigo, 1999a, 2002, 2003b; Dominguez-Rodrigo and Piqueras, 2003; Gifford-Gonzalez, 1989a, 1989b, 1991; O'Connell *et al.*, 2002a; O'Connell *et al.*, 2003; O'Connell and Lupo, 2003; Steele, 2004). For instance, Marean argued that evidence for Neanderthal scavenging within Europe is a methodological construct resulting from the exclusion of shaft fragments from analysis (Marean, 1998; Marean and Assefa, 1999; Stiner, 1994). The absence of a region which has potentially heavy BSM, has significant implications for assessing the interactions between predator-scavengers and hominin populations in terms of carcass access (Marean and Assefa, 1999).

Figure 3.3 shows how I have incorporated the bone regions for each long bone and indicated which zones make up a specific regions, as it is often the division of these elements that proves most contentious (see Dominguez-Rodrigo, 2002). Each zone represents a specific location on each element and allows for zones to be combined and discussed using existing zooarchaeological terms (e.g. proximal epiphysis, distal epiphysis, mid-shaft etc) (Figure 3.3 and Table 3.3)[2]. The scheme employed was similar to those proposed by Dominguez-Rodrigo and Egeland (Dominguez-Rodrigo, 2002, 2003b; Egeland, 2007), and the sub-divisions are illustrated below (see Figure 3.3).

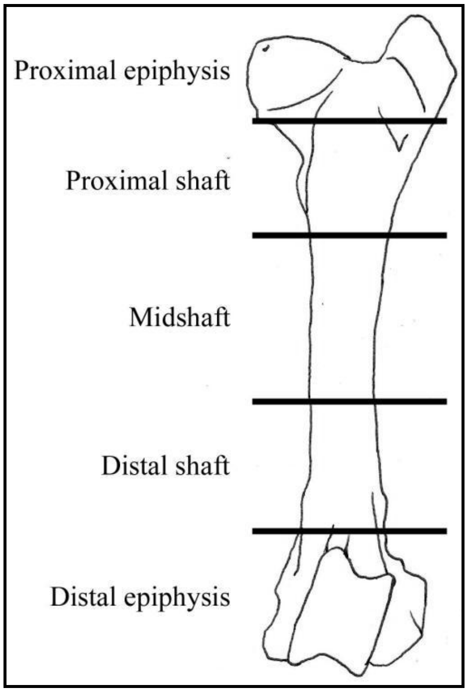

Figure 3.3 Anterior view of femur showing long bone regions
After Egeland (2007, Figure 3.1)

Element	Proximal epiphysis	Proximal shaft	Midshaft	Distal shaft	Distal epiphysis
Humerus	1 & 2	9	10 & 11	7 & 8	3, 4, 5 & 6
Radius	1 & 2	5	6, 7 & 8	9 & 10	3 & 4
Ulna	A, B & C	D & E	F	G & H	J
Femur	1, 4, 5	2, 3	6[3]	7 & 8	9, 10 & 11
Tibia	1, 2, 3 & 4	7	8 & 9	10	5 & 6

Table 3.3 Long bone regions and how these relate to specific zones on each element

The addition of completeness categories for a specific zone (>50%; <50%) made for easier quantification. Multiple specimens with the portion completeness greater than 50% could only have been from different specimens as each element can only have one of each zone

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[2] Detail descriptions and locations for other elements can be found in the Appendix 1.

[3] Includes part of zones 7 & 8 and 2 & 3.

greater than 50% complete. Through quantification of element diagnostic zones the Minimum Number of Elements (MNE) was calculated, from which a Minimum Number of Individuals (MNI) was also determined. For each element, the MNE was calculated by assessing which diagnostic zone had the most representation of >50% present. To increase the accuracy of the MNE calculation, diagnostic zones were combined with side and fusion data, where available, for that specific element. Undoubtedly, it could still be argued that the use of an explicit zonal system is still constrained by the necessity to define where element regions begin and end. Nevertheless, I believe that using a zonal system allows for a more accurate identification of the element and portion survival and, crucially, the location of BSM (section 3.3.4).

Numerous studies have been conducted investigating the bone density of skeletal elements from different species and its potential impacts on assemblage composition and element survival (see particularly Kreutzer, 1992; Lam *et al.*, 1998; Lam *et al.*, 1999; Lam *et al.*, 2003; Lyman, 1994). Stopp (1997, p22) establishes certain consistencies that cross cut species type:

1. Proximal ends of longbones are less dense than distal ends except for the articulated radius which forms a strong joint with the distal humerus
2. Non-articular portions of the scapula and pelvis, the spines and transverse process of vertebrae and ribs are extremely susceptible to deterioration
3. Least affected by attritional forces are the robust acetabulum, metapodial epiphyses, and particularly carpals, tarsals, phalanges and teeth.

By using a quantifiable zonal recording methodology ensured that a particular bone portion was more accurately identified which allowed for a detailed assessment the impact that relative bone density had on faunal accumulation and preservation.

Other element data

As well as recording the specific element and portion preserved, the element form contained data fields that recorded the element side along with the approximate lengths and widths for each specimen (see Figure 3.2). The element side was used to more accurately quantify MNEs and MNIs. The fusion of bone elements was used to provide an approximate age for individuals and helped to assess whether specific age ranges were being targeted. Fusion data was also useful when quantifying and calculating MNEs and MNIs as elements from the same individual generally fuse at a similar rate (Lyman, 1994).

Recording the length and width of each specimen helped to assess whether there had been significant fragmentation of the assemblage. In combination with a detailed analysis of the BSM, this data helped determine whether fragmentation was related to a specific modification agent. Other schemes employed (Schreve, 2006), involved assigning elements to specific size classes (e.g. 0-30mm; 30-60mm; 60-90mm; 90-120mm; 120-150mm; >150mm) but this method can provide considerable overlap between size categories and obscure size difference within and between contexts related to fragmentation by specific taphonomic agents. A precise measurement allowed for more accuracy and for a more direct and quantifiable comparison of faunal assemblage fragmentation. The measurements for each specimen were recorded on separate element forms: however, this system made it more difficult to analyse assemblage fragmentation, and for future analysis these data fields should be located on the main “Find” form.

3.3.3 Bone fracturing

The fracturing of bone has been well documented since the first identification of perceived hominin hunting behaviour (Dart, 1959). As illustrated in Chapter 2, Dart interpreted the fractured remains of animals from South African cave sites as evidence for hunting with weapons by Australopithecines. It was believed that the bone fracturing pattern provided a clear signature of hominin accumulation at a site. Subsequent work by Brain (1981) demonstrated that Dart’s interpretation and assertions were incorrect, and also highlighted that a wide variety of faunal accumulation agents can cause bone to fracture. Further experimental work has been successful in identifying the variation in the type of fracturing caused by predator-scavengers (Becker and Reed, 1993; Binford, 1981; Blumenschine, 1986; Bonnichsen and Sorg, 1989; Brain, 1981; Dominguez-Rodrigo, 2002; Dominguez-Rodrigo and Piqueras, 2003; Lewis, 1997; Marean *et al.*, 1992; Pickering *et al.*, 2004; Turner and Gaudzinski, 1999) and hominins (Binford, 1978, 1981, 1985; Bonnichsen and Sorg, 1989; Brain, 1981; Dominguez-Rodrigo, 1997, 1999b, 2002; Klein, 1987; Roberts and Parfitt, 1999a; Turner and Gaudzinski, 1999), along with other non animal agents (Behrensmeyer and Hill, 1980; Bonnichsen and Sorg, 1989). These studies have illustrated the equifinality of both agents and most importantly illustrated that the freshness of the bone has perhaps more influence on fracture type than the modification agent (Lyman, 1994). Fresher, greener bone tends to fracture spirally whilst older, more brittle bone will break with a more saw toothed morphology (Becker and Reed, 1993).

Bone fractures were recorded using Marshall's (1989) scheme (see Table 3.4), which when combined with BSM evidence allowed an assessment to be made regarding the length of time the faunal material had been exposed and hence the freshness of the carcasses. The edge of each fracture was recorded as either *rough* or *rounded*, which can indicate whether the material was exposed to other natural phenomena such as hydraulic action. Some of the fractures were related to predator-scavenger or hominin subsistence behaviour, and by combining bone fracture patterns with BSM data helped to distinguish between natural and cultural agents of bone fracturing, which is discussed further in the following section (see Section 3.3.4).

Code number	**Fracture type**
1	Stepped or columnar
2	Saw toothed
3	Y-shaped
4	Flaking
5	Irregular perpendicular
6	Smooth perpendicular
7	Spiral
8	Longitudinal

Table 3.4 Code number and fracture type used in database
Based on Marshall (1989)

3.3.4 Recording bone surface modification

Natural

Taphonomic studies have long highlighted the importance of natural agents in the accumulation and modification of faunal remains at archaeological sites (Behrensmeyer, 1978; Behrensmeyer and Hill, 1980; Gifford-Gonzalez, 1989b; Haynes, 1988b; Lyman, 1994; Lyman and Fox, 1989; Marean, 1991; Morton, 2004; Olsen and Shipman, 1988; Stopp, 1993, 1997; Turner, 1999). To fully understand the role and importance of post-accumulation processes and agents, various categories of natural modification were incorporated onto the main "Find" form (see Figure 3.1). These included basic presence/absence categories for abrasion, pitting, hydraulic action, cracking and scratch marks. More detailed categories were developed for specific agents of natural modification such as weathering, root etching and burning (see Table 3.5, Table 3.6, Table 3.7). Behrensmeyer's (1978) weathering scheme was used to assess the exposure period for each specimen.

Weathering stage	Observations	Range in years since death
0	Greasy, no cracking or flaking, perhaps with skin or ligament/soft tissue attached.	0-1
1	Cracking parallel to fiber structure; articular surfaces perhaps with mosaic cracking of covering tissue and bone	0-3
2	Flaking of outer surface, cracks are present, crack edge is angular	2-6
3	Rough homogenously altered compact bone result in fibrous texture; weathering penetrates 1-1.5mm maximum; crack edges are rounded	4-15
4	Coarsely fibrous and rough surface; splinters of bone loose on surface, with weathering penetrating inner cavities; open cracks	6-15
5	Bone falling apart *in situ*, large splinters present, bone material very fragile	6-15

Table 3.5 Weathering stages for large mammals
And description of visible characteristics at each stage; modified from Behrensmeyer (1978)

Although this scheme is widely used throughout zooarchaeology, it is subjective, and consequently, the identification of weathering stages may vary considerably between different reports. I have, therefore, not used the scheme to provide quantification in terms of exposure in years but to provide a more qualitative figure for exposure (i.e. short/long). Behrensmeyer's scheme was combined with detailed BSM and contextual data to help explain patterns that emerged from the data. The scheme assumes relative uniformity in the weathering of bone specimens spatially and temporally. However, the scheme was developed using actualistic observations of modern day bone assemblages which may not weather in the same way as fossil assemblages. Finally, it should be noted that the scheme was developed during experimental work on the African savannah which has a different climatic regime to all the study sites (see chapter 4) and may not be directly comparable.

Other schemes were developed to assess burning and root etching; these were also subjective and not overly detailed. The absence of any evidence for hominin produced fire at the study sites meant that the scale was not used but it is still considered important to retain the category in case the database is used at a site with evidence for burning in the future. The system was based on that developed by Shipman (1988), which records the colour change that occurs to bone when it is heated at certain temperatures (see Table 3.6). Burnt bone would have to be considered along with contextual information that included stratigraphic and palaeobotanical evidence, to assess whether this burning was the result of wild fires or cultural modification. Root etching provides an indication of faunal incorporation into the root horizon and, in combination with weathering data, can help determine exposure of the faunal material on the land surface. There were difficulties in quantifying the degree of root etching but sufficient data was generated when the information was combined with other contextual information.

Colour	Comments
None	Default data label in database
Yellow	Hydroxyapatite
Red brown	Cracking, epiphysis honey-combed
Dark brown to black	Cracking, epiphysis honey-combed
White	Cracking, epiphysis honey-combed

Table 3.6 Scale used to record burnt bone
After Shipman (1988)

Root etching	Comments
None	Default data label in database
Light etching	<25% of specimen
Heavy etching	>50% of specimen
Extreme root etching	Bone surface completely destroyed

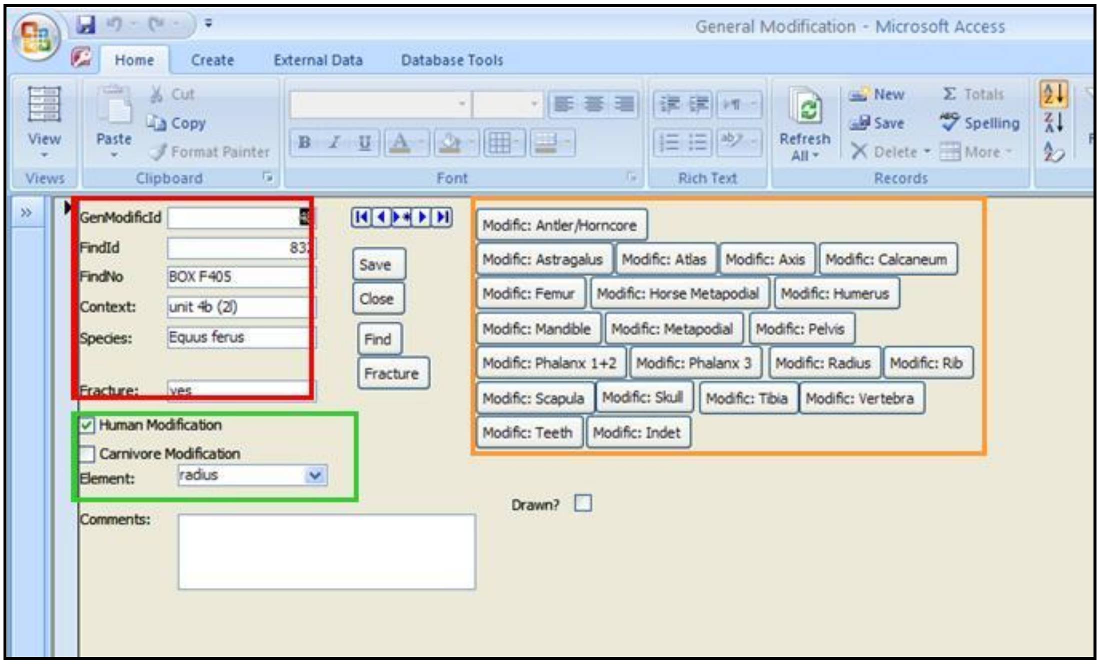
Table 3.7 Scale used to record root etching on bone surface

Predator-scavenger and Hominin modification

Once data on the natural modification of each specimen had been collected, more detailed information on hominin and/or predator-scavenger modification was then recorded. The modification field on the “Find” form has a “yes/no” field, with “no” set as default, when “yes” was selected the database automatically opened the “General Modification” form (see Figure 3.4). This form essentially operated as another gateway that allowed more detailed information on the location of predator-scavenger and hominin modification to be recorded.

Basic site information was automatically imported from the “Find” form which allowed the user to filter and search modification by context and species. The form contained presence/absence fields for hominin and predator-scavenger modification. If both fields were empty then this indicated that the cause of the modification was unknown or related to species palaeopathology. It would be beneficial if future versions of the database incorporated a separate category for palaeopathology, thus allowing for easier querying and inter-site comparison.

The database was deliberately designed to have a “one to many” structure. This structure meant that one record in the “General Modification” form could subsequently generate many records in the secondary form. Likewise, the “Find” and “General Modification” forms had a similar relationship allowing for hominin and predator-scavenger modification to be recorded separately. Such a system was required because, frequently, different types of modification were present on the same specimen. Selection of a specific element from the drop down menu triggered the opening of a separate form that allowed the location of modification on each element to be accurately recorded (see Figure 3.4).



GenModificId:
FindId: 83
FindNo: BOX F405
Context: unit 4b (2l)
Species: Equus ferus
Fracture: yes
☑ Human Modification
☐ Carnivore Modification
Element: radius
Comments:
Drawn? ☐

Figure 3.4 ‘General Modification’ form
Red box- basic contextual information; green box- type of bone surface modification and specific element ; orange box- links to other forms for detailed recording of bone surface modification location.

Extensive experimental fieldwork in varied environments, and often amongst different human populations, has highlighted specific modification signatures that are related to specific carcass-processing events (Behrensmeyer, 1987; Binford, 1978, 1981; Binford, 1987a; Bunn, 1981; Dominguez-Rodrigo, 2002, 2003b; Dominguez-Rodrigo and Piqueras, 2003; Fisher, 1995; Lupo and O'Connell, 2002; O'Connell *et al.*, 2002a; O'Connell *et al.*, 2002b, 2003; O'Connell and Lupo, 2003; Shipman, 1983). Such work has focussed on both human and non-human signatures and has provided a corpus of literature that distinguishes between both accumulation agents as well as evincing the role of each in site and assemblage formation (Fisher, 1995; Gifford-Gonzalez, 1991). To further understand assemblage formation it is essential to be able to distinguish cut marks from predator-scavenger tooth marks and natural trample marks. Fisher’s (1995) extensive review of human BSM provides excellent definitions and distinguishing features for each of these modifications (see Table 3.8).

Modification	Definition
Trample mark	Abundant striations that vary considerably in width and orientation. These striations are frequently accompanied by bone polish
Predator-scavenger tooth scratch	These modifications vary considerably depending on the species (Dominguez-Rodrigo and Piqueras, 2003). Distinguished from cut marks by the steep, often ‘u-shaped’ sides, and uniform depth. Usually accompanied by other modifications such as pitting (see Table 3.9)
Human cut mark	Caused by contact between stone tool and surface of bone. Usually an elongated, relatively narrow, linear striation and often ‘v-shaped’ in cross section. Often there are fine micro-striations within the cut mark border.

Table 3.8 Definitions and distinction of trample mark, predator-scavenger and human modifications After Fisher (1995)

Although cut marks and predator-scavenger modification provide evidence for these agents as modifiers, other behavioural patterns can be identified by analysing the location of BSM on a specific element or region. For instance, Binford (1978; 1981) identified hominin cut marks on or around long bone epiphyses, the base of the skull and on metacarpals as evidence for skeletal disarticulation. Similarly, cut marks identified on long bone shafts, particularly the humerus and femur, are considered evidence of butchery and meat removal (Binford, 1981; Bunn, 1981, 1983; Dominguez-Rodrigo, 2002; Roberts and Parfitt, 1999b). Simlarly, predator-scavenger modification on long bone shafts has been used as evidence for meat removal and primary access to animal carcasses (Binford, 1981; Egeland, 2007; Hill, 1983; Kruuk, 1972; Lupo and O'Connell, 2002). Conversely, carnivore modification around long bone epiphyses or on the distal appendicular skeleton has been interpreted as evidence of secondary access to the carcass (Stiner, 1994). Hominin and predator-scavenger BSM located on the same specimen can sometimes overlap and thus provide more definitive evidence regarding access to the carcass (see for example Roberts and

Parfitt, 1999a). All potential human and predator-scavenger BSM could be selected on the modification form; descriptions and definitions are detailed below (see Table 3.9 and Table 3.10).

Modification	Description
Crenelation	Gnawing of bone around the epiphysis creating uneven, scalloped edges.
Predator-scavenger puncture wound	Hole caused by canine teeth
Digestive corrosion	Bone passed through carnivore digestive tract and subsequent regurgitated. Heavily pitted and fragile
Predator-scavenger tooth pit	Carnivore teeth cause a 'depression' on the bone surface and not a complete puncture
Rodent gnawing	Chisel like incisors of rodents create an identifiable signature of relatively flat grooves which are broad, flat bottomed and round in cross section. Often in long, regular rows.

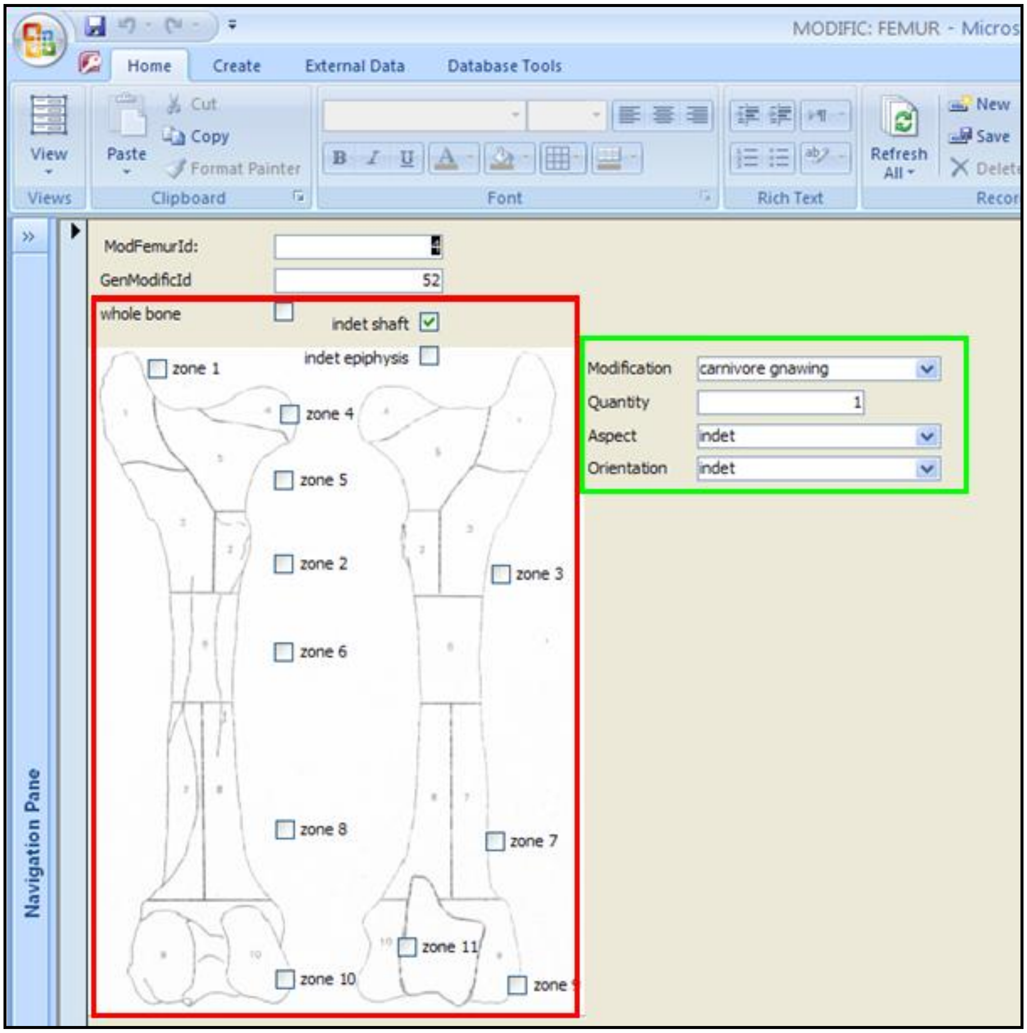
Table 3.9 Definitions of predator-scavenger modifications
After Fisher (1995)

Modification	Description
Chop marks	Broad, relatively short, linear mark with 'v-shaped' cross section.
Deliberate fracturing	Fracturing of long bone by striking it with hammerstone, Impact point can be identified by a conchoidal flake scare on the bone edge.
Disarticulation	Separation and removal of skeletal elements and identified by cut marks on or near long bone epiphyses or at the base of the skull
Filleting marks	Cut marks along the length of the shaft, usually perpendicular to long-axis, indicating removal of meat.
Skinning marks	Cut marks on the most distal skeletal elements (podials, metapodials and phalanges)
Scrape marks	Closely spaced and parallel cut marks that are relatively narrow
Puncture wound	Hole in bone caused by impact of projectile. Usually larger and less uniform than predator-scavenger puncture wound
Percussor	Use of bone for soft hammer lithic manufacture. Identified by pitting on bone surface and small lithic fragments embedded in the surface of the bone.

Table 3.10 Description of Hominin modifications
After Fisher (1995)

Behavioural interpretations are constrained by the different methodological schemes used to record element and portion, which has culminated in a heated debate amongst several authors (Dominguez-Rodrigo, 1999a, 2001, 2002, 2003a, 2003b; O'Connell *et al.*, 2003; O'Connell and Lupo, 2003). Dominguez-Rodrigo (2002; 2003a) argued that O'Connell and Lupo's method for recording bone specimens resulted in inaccuracies when recording the location of bone surface modification, and rejected their interpretation of hominin subsistence.

Thus, for clarity and comparison the same modified zonal system used to record bone portion was also used to record predator-scavenger and hominin modification on specimens (Dobney and Rielly, 1988) (see Figure 3.5). Using the same system meant that the location of the BSM could be precisely and accurately recorded on each specimen and helped when discussing its location within the framework of the bone regions outlined above (see Section 3.3.2). In addition, the continuity in recording schemes allowed for a synthesis and integration of BSM data with other information on bone and portion survival; this procedure allowed for a direct comparison of modification location within and between species and assemblages. The different types of hominin modifications were first input into database "code" tables. Many of the hominin modifications described above are interpretive and reliant on the identification of cut marks at a specific bone location to indicate a behavioural signature. Therefore, in order to not anticipate the data, at this stage of analysis, all lithic tool modifications were recorded as "cut marks" and did not assume that the location of these modifications represented a specific behavioural signature.



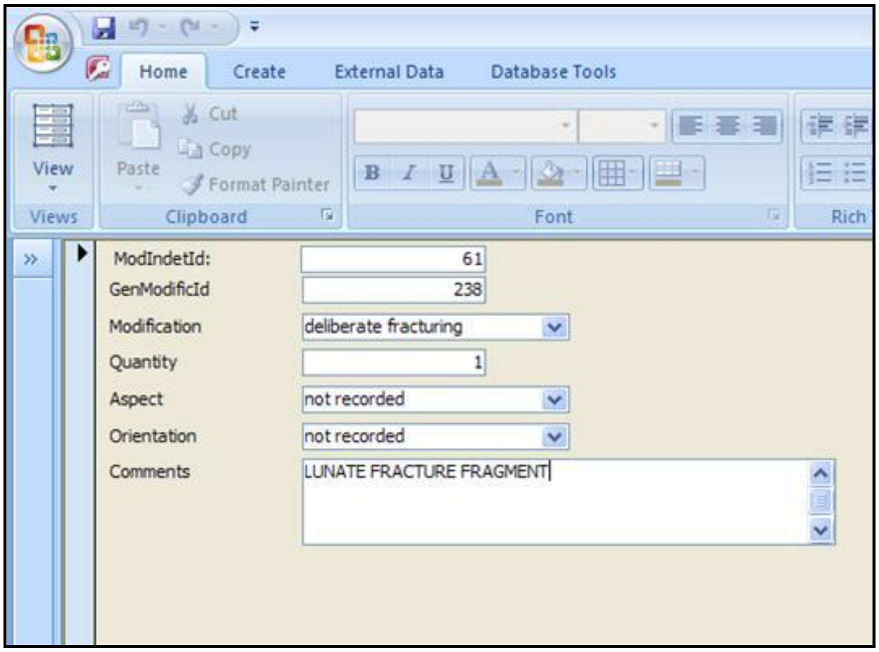
ModFemurId:
GenModificId: 52
whole bone ☐
indet shaft ☑
indet epiphysis ☐
☐ zone 1
☐ zone 4
☐ zone 5
☐ zone 2
☐ zone 3
☐ zone 6
☐ zone 8
☐ zone 7
☐ zone 11
☐ zone 10
☐ zone

Modification: carnivore gnawing
Quantity: 1
Aspect: indet
Orientation: indet

Figure 3.5 'Modific: Femur' form to record location of hominin and predator-scavenger BSM
Red box- zonal system to record location of modification; green box- type, quantity and orientation of modification.

Additional information was recorded for each specimen that included the quantity of hominin and predator-scavenger modification along with the aspect and orientation of the modification. The quantity of modification illustrated the intensity of processing for each agent (hominin/predator-scavenger) and the impact of each agent in assemblage modification.

If possible, BSM was recorded on indeterminate fragments to provide a consistency that allowed for comparisons with the identifiable fragments. If the specimen could be assigned to an element, then the modification was located within general categories (*proximal epiphysis, shaft, and distal epiphysis* etc). However, if the specimen could not be assigned to a specific element, and thus the zooarchaeological viewpoint determined, then the modification was recorded spatially/geographically on the specimen using categories such as *edge of specimen* and *end of specimen* (see Figure 3.6). Recording BSM on indeterminate fragments allowed for a holistic assessment of carcass-processing by both predator-scavengers and hominins and allowed modifications on these specimens to be used in a wider discussion of meat-procurement and carcass access.



ModIndetId: 61
GenModificId 238
Modification deliberate fracturing
Quantity 1
Aspect not recorded
Orientation not recorded
Comments LUNATE FRACTURE FRAGMENT

Figure 3.6 'Modific: Indet' form for recording BSM on indeterminate specimens

Initially, all specimens that illustrated hominin and/or predator-scavenger modification were going to be hand drawn onto pre-prepared skeletal element outlines similar to those developed elsewhere (Popkin, 2005). However, by using the zonal system to record the location of the modification, along with extensive digital photography, it was felt that the use of additional outline drawings was excessive. These element outlines are available and are useful for recording element preservation and modification when access to a database or computer is restricted. These templates will be used in future as an *aide-memoire* when recording faunal material and modification in the field.

The first sections of this chapter have outlined the methodology used to collect primary faunal data on element and portion survival, as well as detailed information on natural, predator-scavenger and human modification. Previous chapters have discussed the importance of synthesising primary data from faunal analysis within an overall site framework. Contextual data on the site palaeoenvironment, depositional environment and animal behavioural ecology can assist in the interpretation of any patterns that emerge during faunal analysis. The next section deals with the collation and synthesis of such information.

3.4 Contextual information

As discussed above (see section 3.1) it is essential to analyse and discuss faunal assemblages within their site context in order to be confident about the conclusions reached (Gifford-Gonzalez, 1991). Ignoring the role of other taphonomic agents may result in an interpretation that is skewed, inaccurate and may actually overemphasise the role of hominins in site formation. It is important therefore to have "multiple, independent sources of knowledge" (Gifford-Gonzalez, 1991, p236). The following section will highlight and discuss some of the sources of knowledge used throughout this study to provide context for the faunal analysis highlighted above.

3.4.1 Site reports

The monograph for each study sites was the major source of information on the palaeoenvironment and depositional environments (Boismier, 2003, in press-a; Conway *et al.*, 1996; Roberts and Parfitt, 1999a; Schreve, 2006, in press; Singer *et al.*, 1993). Understanding the sedimentary conditions in operation at these sites helped evince whether any of the patterns observed in the faunal data could be the result of natural accumulation. The specialist reports, such as those on molluscs, pollen, and vegetation, provided further contextual data and a finer palaeoenvironmental resolution which complemented the data on the depositional environment. The use of a contextual framework is similar to the approach advocated by Gifford-Gonzalez (1991) and undertaken by Stiner (1994) during her analysis of Middle Palaeolithic Italian cave sites. Stiner's approach consisted of a similarly detailed palaeoenvironmental reconstruction as well as a detailed understanding of the sedimentary conditions operating at each of the study sites. In addition, Stiner utilised niche theory in order to elucidate further the position of hominin communities within the wider palaeoenvironmental framework.

3.4.2 Predator and prey behavioural ecology

Comparative animal behavioural ecology was utilised to highlight the potential for competition between hominins and other predator-scavengers and to assess the impact of predator and prey behaviour on subsistence strategy and access to animal products (meat, marrow etc). Reconstruction of the palaeoenvironments and communities which populated them, required the use of analogical reasoning to “revisualise” these past contexts (Gifford-Gonzalez, 1991). However, using modern data to understand prehistoric non-analogue communities needs to be undertaken with caution otherwise it might result in the imposition of modern behaviour onto past communities. In this study, modelling used palaeoenvironmental proxies to reconstruct the resource availability and potential species interactions by comparing this with modern behavioural ecology data.

A study of modern carnivore behaviour (hunting and carcass consumption) helped assess past resource availability, areas of potential competition with hominins and finally the niche occupied by these hominin populations (Krusimba, 2003; Kruuk, 1972). It was also important to study the behaviour and life cycles of prey animals as these would have similarly impacted on the subsistence methods employed and may have necessitated behavioural modifications in order to successfully exploit these resources.

The use of predator and prey behavioural ecology is a useful method for modelling interactions and potential conflicts for resources (Stiner, 1994). Throughout this research I have undertaken a high level contextual analysis and combined this with basic low level modelling of predator and prey behavioural ecology. Both of these strands of contextualisation have meshed well and allowed for a more detailed understanding of site and assemblage formation and the interaction and importance of predator-scavengers and hominins at these sites (see chapters 5-8). For future research, I would like to undertake more detailed behavioural modelling of prey, non-human predators and hominins to assess interactions and potential conflicts for resources. Whether such modelling would involve a GIS based approach is currently being investigated.

3.5 Data Analysis

After collection of the primary faunal data using the database described above I constructed tables and graphics to demonstrate the main trends within the data. Each site was analysed separately in order to fully understand the factors affecting site and assemblage formation. The data was analysed by context and also by species and approached through the following sections and themes:

1. *Contextual data and natural modification agents and processes*

Through a review of the site reports the main sedimentary regimes responsible for the deposition of the excavated contexts at each of the study sites were identified. It was important that these regimes were isolated in order to assess whether certain natural factors needed to be considered prior to other natural modification. For instance, if there was evidence for fluvial or tidal activity within the sedimentary sequence it was necessary to plot the faunal long-axis orientation and assess the importance of this agent in assemblage accumulation. By comparing the intensity and distribution of natural modifications such as abrasion, cracking, and fluvial modification within the sedimentary contexts helped explain the role and importance of these agents in faunal accumulation and modification. For example, a low quantity of hydraulic modification on faunal material from a river deposit suggested limited exposure to fluvial processes and hence a limited role for the river channel in bone accumulation and modification. By synthesising this natural modification data within the sedimentary context at each site helped assess whether the differences in skeletal representation, between and within species, could be explained solely as a result of the natural modification agents (see sections 1 and 2).

2. *Faunal assemblage weathering*

The weathering of faunal material varies in relation to factors such as climate, time of exposure and type of bone and thus, it was important to similarly consider bone weathering data from each study site within the context of the sedimentary regime. Analysis of faunal weathering patterns helped elucidate post-depositional processes such as bone rolling and root etching to assess the rapidity of burial and also the extent of faunal material re-exposure. Weathering data was plotted for the entire assemblage to produce a general pattern and then broken down further into context and species plots. Focussing on context and species allowed an assessment of whether different sizes of animals or types of contexts illustrated different exposure rates. Weathering data was combined with contextual information on sedimentary conditions and natural modification along with evidence of predator-scavenger and hominin modification to help explain faunal accumulation and carcasses access (see section 4).

3. *Species specific analysis*

Each species was analysed separately though intra-species comparisons were drawn throughout. Each species skeletal profile was plotted using the NISP values for each element. The material was then quantified to produce MNE and MNI figures that were plotted against the NISP values to assess the degree of assemblage fragmentation. Assemblage quantification was then assessed in the context of the sedimentary sequence, weathering and natural modification data to see whether these patterns were related to natural processes. It was vital to determine that the observable pattern was not the result of the differential destruction of less dense skeletal elements. To demonstrate that there was no evidence for density mediated destruction each element was divided into bone zones (e.g. proximal epiphysis, proximal shaft) and the number of specimens present within each zone was recorded. If the patterns of skeletal representation and modification could not be adequately explained through natural factors alone then the presence of hominin and/or predator-scavenger modification on the fauna would provide greater certainty that the faunal remains accumulated as a result of both hominin and non-hominin agents.

4. *Predator-scavenger/ hominin modification*

Detailed analysis and understanding of the sedimentary sequence and other natural modification agents provided greater understanding of the role and importance of hominins and carnivores in faunal accumulation. The analysis documented and discussed the importance of both hominin and non-hominin carnivores in assemblage formation and what such information meant in terms of behaviour, carcass access and existing theories about subsistence at each study site. The location of predator-scavenger and hominin modification was mapped onto animal skeletal outlines to highlight distribution across each species and identify regions of overlap and absence. The type and location of both hominin and predator-scavenger modification was considered alongside skeletal part representation to see if the absence of certain elements could be explained by off-site transport or destruction during carcass-processing.

A holistic approach that assesses all taphonomic factors responsible for faunal assemblage accumulation ensured that the analysis and interpretations of hominin input, if any, have been thoroughly assessed. The use of animal behavioural ecology data in combination with the palaeoecological and zooarchaeological data has allowed for more predictive modelling in terms of resource availability and the potential structure of hominin subsistence (Blumenschine, 1986, 1988; Stiner, 1994; 2002). The methodology developed for this study has provided a site specific contextual framework for the analysis of faunal remains from Palaeolithic sites. It is important to emphasise that all the archaeological material was influenced, to varying degrees, by the depositional environments and regimes at each site. This is axiomatic as no archaeological material is deposited in a vacuum. To develop a fuller understanding of the role and importance of hominins within site and assemblage formation requires a methodology that considers meticulous faunal analysis within a detailed site specific framework, developed through a synthesis of site contextual and palaeoenvironmental material.

This chapter has detailed a methodology focussed specifically on the recording of all taphonomic agents of faunal modification and contextualising these within a palaeoecological and depositional framework. The next chapter provides detailed information about each of the study sites which will be contextualised in subsequent chapters during the analysis of the primary faunal data.

Chapter 4 Site Backgrounds

4.1 Introduction

The previous chapters have outlined the background and ongoing debates about hominin subsistence on a European scale and more specifically, for this project, the British context. The purpose of this chapter is to provide detailed contextual information about each of the sites studied in this thesis, and referred to, throughout the subsequent analysis and discussion. In this chapter the sites are discussed in chronological order: the location; depositional environment; stratigraphy; fauna; palaeoenvironment; and evidence of a hominin presence are highlighted for each. Figure 4.1 shows the major climatic shifts throughout the Pleistocene and highlights the chronological position of the each study site in relation to other British archaeological localities, whilst Figure 4.2 illustrates the spatial distribution of the sites within Britain.

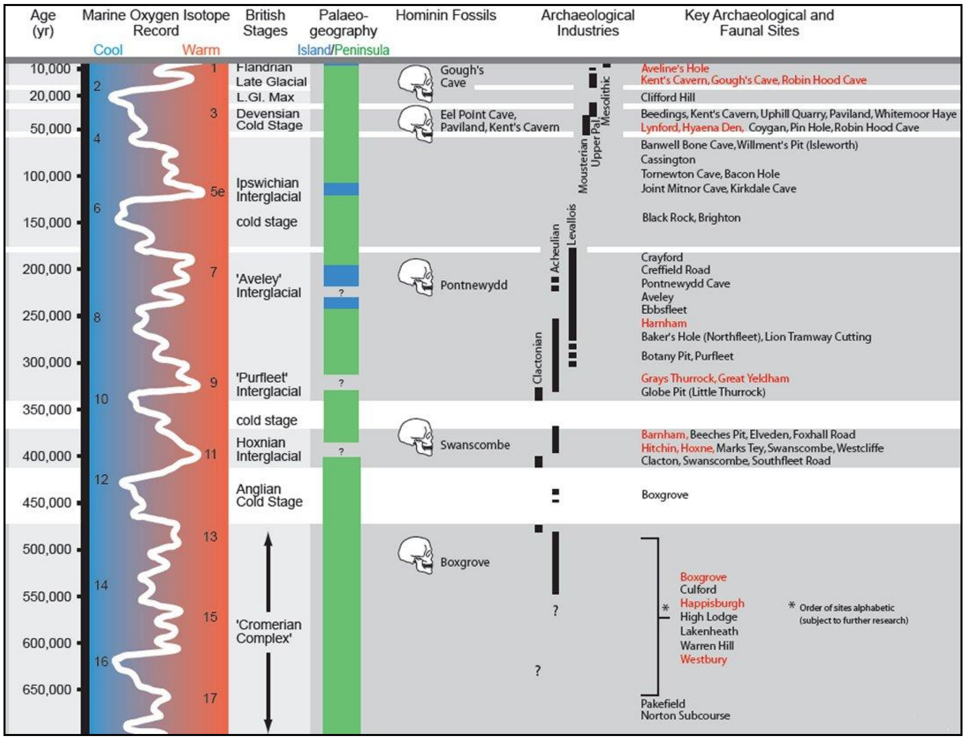


Figure 4.1 Marine Isotope Stages during the Pleistocene with key British archaeological sites From Ancient Human Occupation of Britain website (http://www.nhm.ac.uk/hosted_sites/ahob/index_2.html)

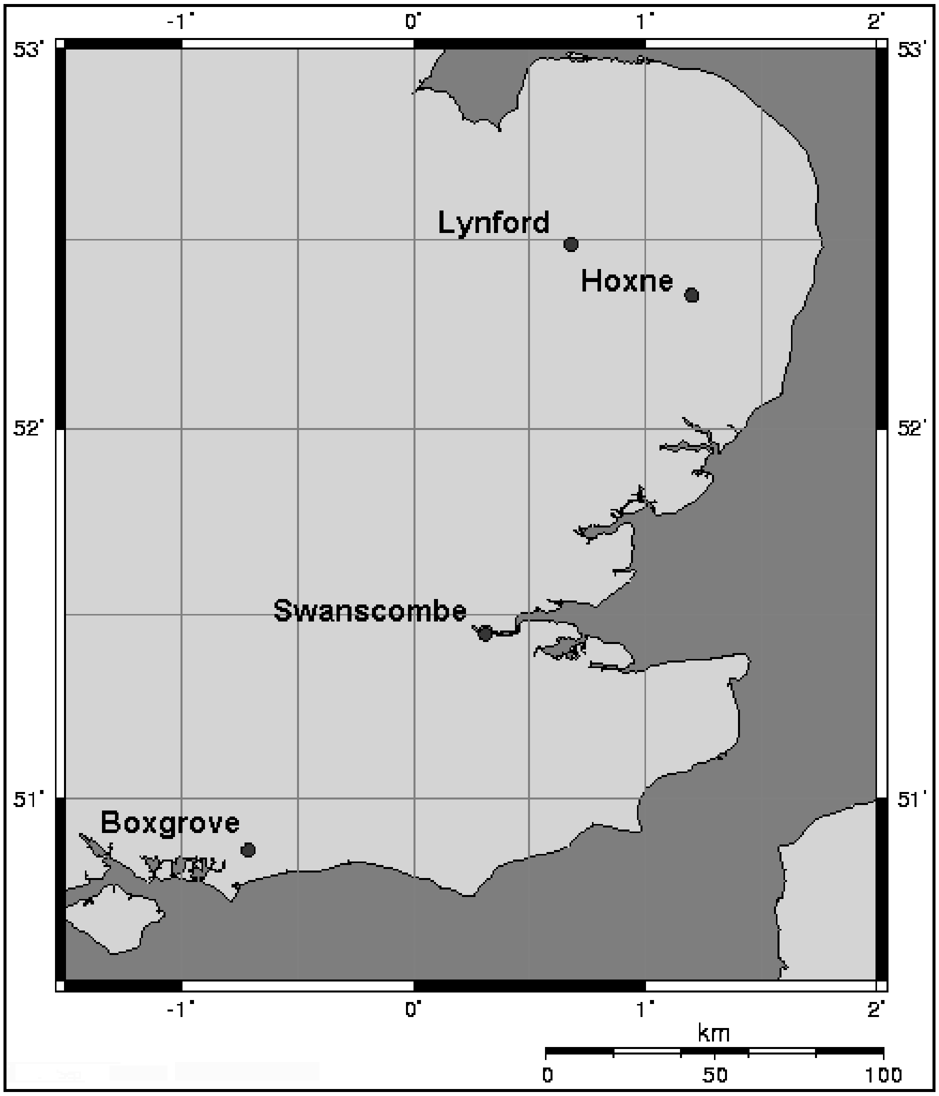


Figure 4.2 Location of UK study sites analysed for this thesis, on a map of southern England

4.2 Pre-Anglian (MIS 13)

4.2.1 Boxgrove

Until the discovery of lithic tools and modified fauna from the Cromer Forest bed on the East Anglian coast (Parfitt *et al.*, 2005), Boxgrove represented the earliest definitive evidence for hominins in Britain prior to the Anglian Glaciation (MIS[4] 12). The site had previously been identified by Shephard-Thorn (1978) and was later discussed by Woodcock (1981). However, it was not until 1983, when the current Boxgrove project started, that systematic survey and excavation of these deposits was undertaken (Roberts,

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[4] Marine Isotope Stage

1986; Roberts *et al.*, 1995; Roberts and Parfitt, 1999a; Roberts *et al.*, 1997). Extensive quarrying and mineral extraction along the southern margin of the dip slope of the South Downs exposed Middle Pleistocene sediments and preserved land surfaces capped by cold stage solifluction deposits (Roberts and Parfitt, 1999a). By using a number of biostratigraphically important mammalian species, the marine, intertidal and lower terrestrial units have been dated to the late 'Cromerian' *sensu lato* (Parfitt, 1999a). This provides an approximate age of c490- 480kyr bp and situates the site in the latter stages of Marine Isotope Stage (MIS) 13 (c. 528-478 kyr bp) and the early phases of the ensuing Anglian glaciations (MIS 12; c. 478-427 kya).

Location and stratigraphy

Boxgrove is located 7km east of Chichester (West Sussex) at the junction between the South Downs and the Sussex Coastal Plain (Roberts and Parfitt, 1999a) (see Figure 4.2 and Figure 4.3).The Coastal Plain, as a geographical province, extends from eastern Hampshire in the west to Brighton in the east and has been shaped by marine action in the form of a series of transgressions and regressions beginning 500kyr and continuing up to the present day (Roberts and Parfitt, 1999a). The area is bounded by chalk downland to the north and slopes gently into the English Channel to the south (ibid).

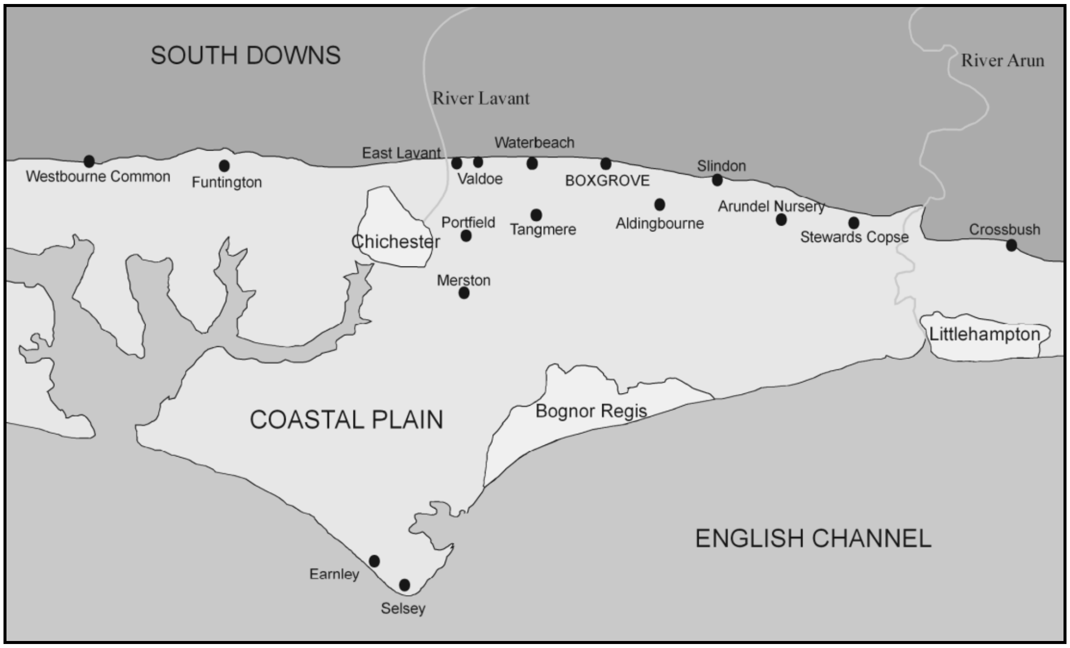

Figure 4.3 Location of Boxgrove and other Quaternary sites on West Sussex Coastal Plain Area shaded dark grey represents chalk downs; modified from Pope (2002, Figure 3.1)

The Boxgrove sites are located in two disused quarries, where the excavated sediments overlie and abut the solid chalk (see Figure 4.3). At the northern end of Quarry 2 the wave cut platform rises into a cliff which was visible in section (Roberts, 1999c). Geophysical survey has plotted the probable position of the cliff line in the area of Boxgrove (Lewis and Roberts, 1999) (see Figure 4.5) . Estimates suggest that the cliff would have been 75-100m high during the Middle Pleistocene and comparison has been made with cliffs along the present day East Sussex coast (Roberts, 1999c). Subsequent mapping of these sediments, in relation to the solid chalk geology, suggests that the site of Boxgrove was situated within a semi-enclosed marine bay (Barnes, 1980) formed by the extant Portsdown and Littlehampton Anticlines (Roberts and Pope, in press). The Pleistocene sediments at Boxgrove were deposited during a major warm climatic episode (Slindon Formation) and are overlain by sediments laid down during the final part of the temperate stage and the ensuing cold stage (Eartham Formation) (see Figure 4.6 and Table 4.1).

The Slindon Formation consists of the Slindon Sand (Unit 3), which immediately overlies the chalk wave cut platform, deposited during a sea level event, at least equivalent to today’s ordnance datum, at the end of the Cromerian Complex (see Figure 4.6 and Table 4.1). The composition of the sands suggests these were laid down as nearshore, subtidal and intertidal deposits. The absence of longshore drift structures within the sand suggests a protected coastline as suggested by the mapped cliff line and Slindon Formation deposits (Roberts and Pope, in press). The transition from the Slindon Sand to the Slindon Silt (Unit 4) can be seen through an increase in deposition of finer sediments but most strikingly from the change in colour from a yellow to grey-green unit. The silt deposits represent intertidal mudflat deposition within a protected salt water embayment (Unit 4a and 4b). The formation of these mudflats indicates the regression of the sea, perhaps with periodic transgressions, at higher tides, replenishing material within the bay.

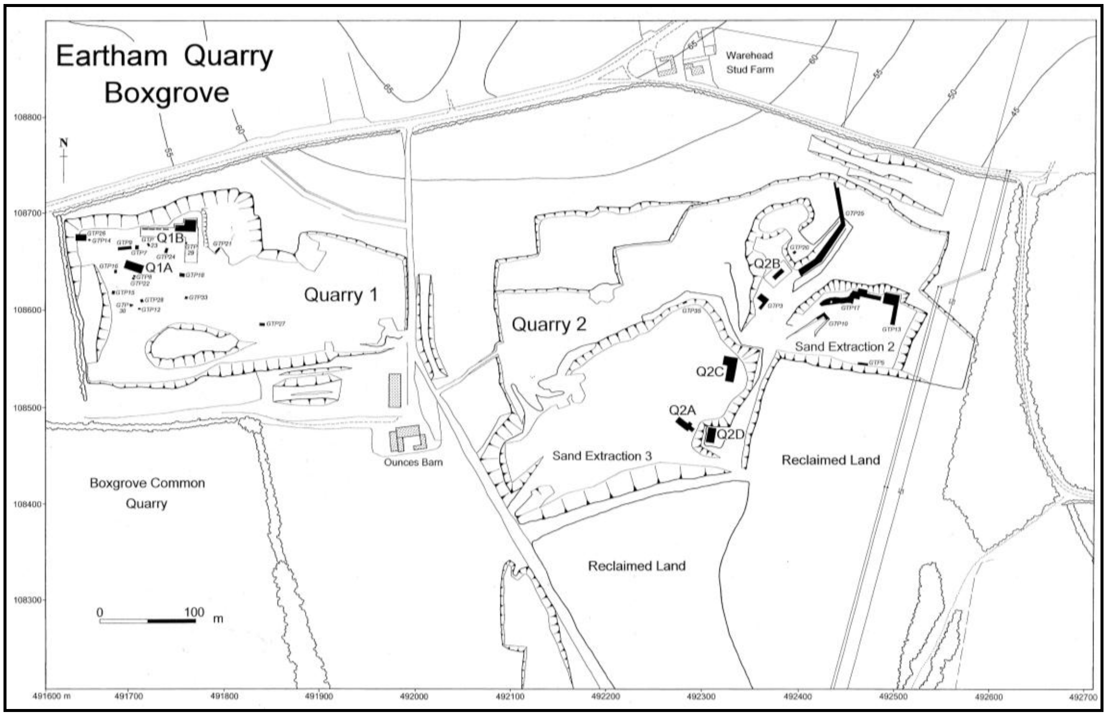

Figure 4.4 Eartham Quarry 1 and 2, Boxgrove showing principal excavation areas
After Roberts and Parfitt (1999a, Figure 4)

The end of the marine influence at Boxgrove can be seen on the surface of the Slindon Silts where a soil developed quickly after the sea had fully regressed (Unit 4c). This soil horizon was open for between 20-100 years during which time a flat grassy plain developed in front of the cliff. The increasing wetness of this environment (Macphail, 1999) eventually led to the flooding of the soil surface and the formation of a marsh/mire deposit (Unit 5a). This horizon can be traced across the entire conformable sequence at Boxgrove and represents a transitional horizon between the Slindon and Eartham Formations.

The start of the Eartham Formation marks the gradual transition into the Anglian Glaciation (MIS12) though some of the lower members of this formation were laid down during temperate conditions. The capping of the deposits at Boxgrove by Head Gravels marks the full onset of the Anglian Glaciation and has served to preserve the underlying deposits containing the archaeology.

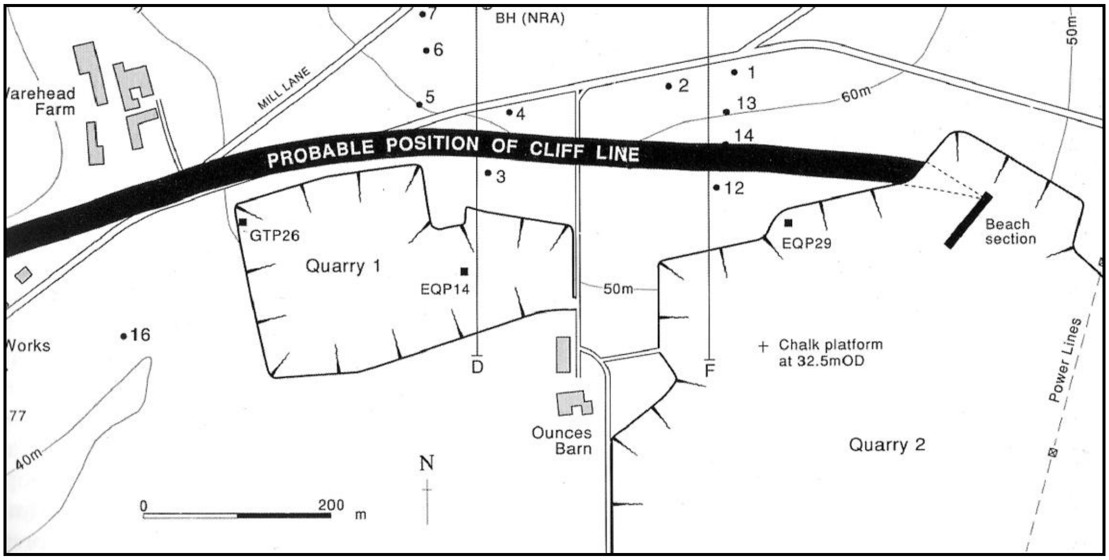

Figure 4.5 Position of cliff line in relation to Boxgrove quarries showing position of boreholes and quarry edges; Roberts and Parfitt (1999a, Figure 30)

The Pleistocene deposits at Boxgrove reflect a cooling of climate throughout the Slindon Formation, represented by a transition from marine influence throughout the Slindon Sand and, periodically, throughout the Slindon Silt to a colder fully terrestrial sediment system. The change from marine to terrestrial sediment input reflects a eustatic and ongoing tectonic change in land and sea level that occurred prior to and during the Anglian Glaciation (Roberts and Parfitt, 1999a).

Unit		Environment	Climate
11	Head gravels	Terrestrial	Cold
10	Calcareous head gravel	Terrestrial	Cold
9	Fan gravel beds	Terrestrial	Cold-cool
8	Chalk pellet beds	Terrestrial	Temperate-cool
7	Angular chalk beds	Terrestrial	Temperate
6	Brickearth beds	Terrestrial	Cool-cold
	Calcareous silty clays	Terrestrial	Temperate and cool
5c	Clay loam layer	Terrestrial	Cool/temperate
5b	Marl	Terrestrial	Cool
5a	Iron and manganese pan/organic bed	Terrestrial	Temperate
4d	Alkaline (pond) marl	Terrestrial	Temperate
4c	Slindon silts (decalcified upper layer)	Terrestrial	Temperate
3/4, 4, 4u, & 8c	At Q1/B waterhole	Freshwater/ Terrestrial	Temperate
4b	Slindon silts (calcareous and laminated deposit)	Lagoonal/intertidal	Temperate
4a	Slindon silts (homogenised calcareous sediment)	Lagoonal/intertidal	Temperate
3	Slindon sand	Marine cycles 1,2, 3	Temperate
2	Raised beaches	Marine cycles 1,2, 3	Temperate
1	Chalk platform and cliff	Marine cycles 1,2, 3	Temperate

Table 4.1 Summary of Boxgrove stratigraphy, depositional environment and climate
Modified from Roberts and Parfitt (1999a, Table 21)

Micromorphological analysis of the sediments identified mineralised plant remains and root traces and an absence of any large scale vegetational bioturbation (Macphail, 1999). Additionally, the low incidence of rootlet action recorded on mammal bones, and limited vertical displacement of the lithic assemblage suggests that in the fine-grained deposits in front of the cliff, vegetation was restricted to grasses and herbaceous vegetation (Parfitt, 1999b). The presence of woodland on the Downland block has been identified by the occurrence of mineralised detritus within the marsh deposit (Unit 5a) along with the incidence of certain species of molluscs and mammals (Macphail, 1999; Preece and Bates, 1999). The absence of vegetational disturbance within the fine-grained deposits suggests that both the lithic and faunal assemblages were relatively undisturbed, which is very unusual for a Lower Palaeolithic site.

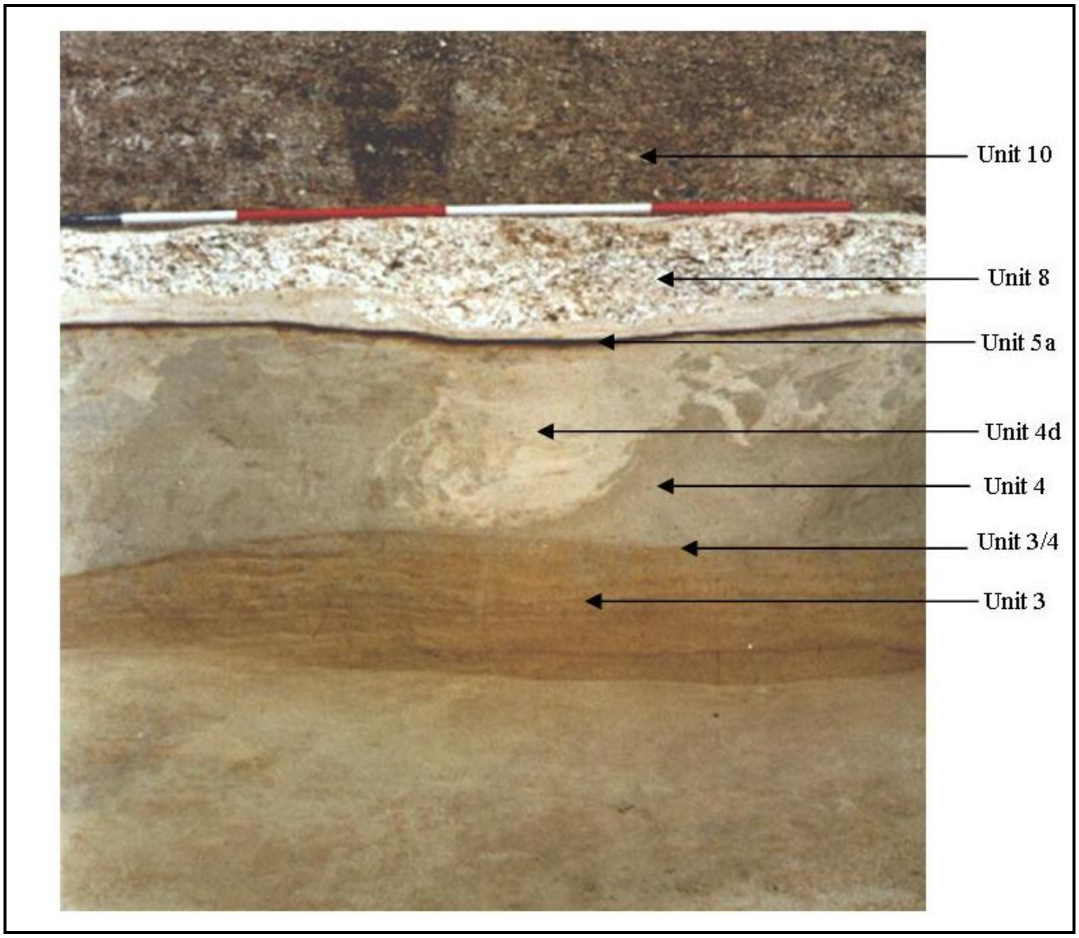

Figure 4.6 Boxgrove stratigraphic sequence from Q1/B waterhole
Note freshwater deformation of Unit 4; scale in 0.25m increments; photograph by M.B. Roberts (used with permission)

Faunal material and palaeoecology

The faunal assemblage recovered during excavations at Boxgrove is one of the most diverse consisting of 50 species, 11 of which are extinct (Parfitt, 1999a, 1999b). The site has produced one of the richest Pleistocene large/medium faunal assemblages including elephant (*Elephantidae sp*.), rhinoceros (*Stephanorhinus hundsheimensis*), equid (*Equus ferus*), cervids (*Cervus elaphus, Dama dama, Capreolus capreolus, Megaloceros dawkinsi*), bison (*Bison priscus*) and carnivores (*Panthera leo, Crocuta crocuta*). In addition, a similarly rich and diverse assemblage of small mammals, fish, amphibians, birds and reptiles has been recovered (see Parfitt, 1999a for detailed information). Although faunal material was recovered throughout the stratigraphic sequence the majority was recovered from the terrestrial Slindon Silt Member (Unit 4c) and the Unit 4c equivalent at the Q1/B waterhole, the marsh/mire deposit (Unit 5a), and the base of the Eartham Lower Gravel Member (Table 4.1) (Parfitt, 1999a).

The mammal assemblage from Unit 4c indicates an increase in vegetational diversity compared with the underlying horizons and suggests a mosaic of environments. The presence of various vole species (e.g. *Arvicola terrestris. cantiana, Microtus. argrestis*) along with grazing species such as horse (*Equus ferus*) suggests the existence of open grassland environments around the site. Similarly, the occurrence of large carnivores such as lion (*Panthera leo*), which hunt on large open plains, can also be used as evidence of a grassland environment. However, the identification of arboreal species such as squirrel (*Sciurus* sp.), along with badger (*Meles* sp.), roe (*Capreolus capreolus*) and fallow deer (*Dama dama*) suggest both deciduous and mixed woodland near to the site. Although the existence of both grazing and woodland species would appear incompatible, many woodland species, especially deer, feed on the woodland margins. Furthermore, micromorphology suggests that trees and scrub did not colonise the plain south of the cliff line (Macphail, 1999). Grazing herbivores eat new woodland growth, which could explain why this area remained uncolonised by woodland vegetation. However, there probably were isolated stands of trees and scrub, similar to modern savannah environments, and rooting structures from these species may not have been preserved, or else have been masked by grassland rooting structures. A similar habitat preference has been recorded for Unit 5a, although the numbers of tundra and boreal species is markedly increased (Parfitt, 1999a). The increase in these species suggests a cooling of the climate, although the overall faunal and climatic proxies still indicate a temperate environment.

The greater concentration of fauna within the terrestrial sediments is unsurprising given the marine environments of the sand and intertidal mudflat deposits (Roberts, 1999c). It is not until the formation of a land surface at Boxgrove that the immediate environment was able to sustain large quantities of mammals. Both small and large mammal assemblages indicate a mosaic environment with both deciduous and mixed woodland at the base of the disused cliff, and open grassy plains further south probably maintained by the activities of grazing herds. The faunal remains indicate a gradual cooling throughout the Slindon Formation until the onset of glacial conditions within the Eartham Formation. This gradual climate change is represented by the appearance of cold adapted species such as lemming (*Lemmus lemmus*) and ibex (*Capra ibex*), and a return to a more open landscape. By establishing a palaeoecological context as outlined above it is now possible to situate and discuss evidence for hominin communities within the Boxgrove palaeolandscape.

Evidence for hominins: Palaeolithic archaeology and modified fauna

The remains of a tibia and two incisors, assigned to *Homo cf. heidelbergensis*, physically illustrate the presence of hominins within the site's mammalian palaeocommunity (Stringer and Trinkaus, 1999; Stringer *et al.*, 1998; Trinkaus *et al.*, 1999). However, the clearest behavioural evidence for a hominin presence is the large quantity of lithic material recovered from the site (Austin *et al.*, 1999). The assemblage is dominated by handaxes and related debitage made on flint acquired from the base of the relict cliff (see Figure 4.7). Most of the bifaces are ovate in shape; some have been considerably thinned and finally sharpened through the removal of tranchet flakes (Wenban-Smith, 1999). Although tools are found throughout the sequence the majority were recovered from the terrestrial land surface (Unit 4c) and its temporal equivalents at the Q1/B waterhole (see Table 4.1). These fine-grained deposits have been minimally disturbed and illustrate little vertical displacement demonstrating a relatively *in situ* lithic assemblage and allow for a more detailed analysis and understanding of hominin behaviour within the landscape (Roberts, 1999b). At some localities (GTP 17, Unit 4b) it has been possible to isolate the knapping scatters of at least four individuals around a horse carcass (see Figure 4.8). At this location the entire *chaîne opératoire* is recorded suggesting that raw material was acquired from the nearby cliff, transported back to this specific location, knapped into a handaxe and then the tool was removed from the site. The close proximity of the cliff certainly allowed for a plentiful supply of raw material and allowed the unconstrained production of these tools.

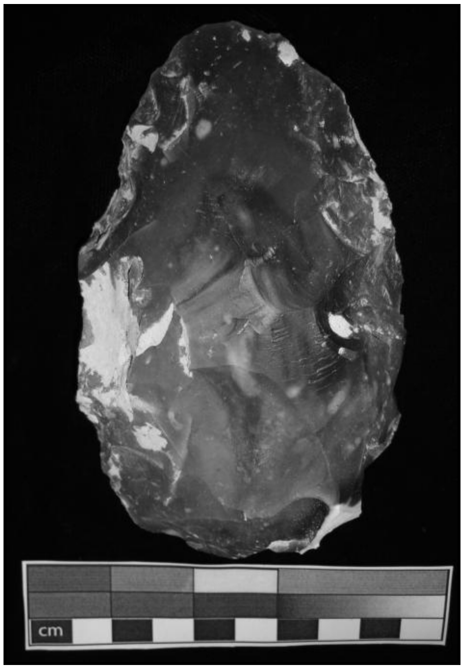

Figure 4.7 Ovate biface recovered from Quarry 1, Unit 4

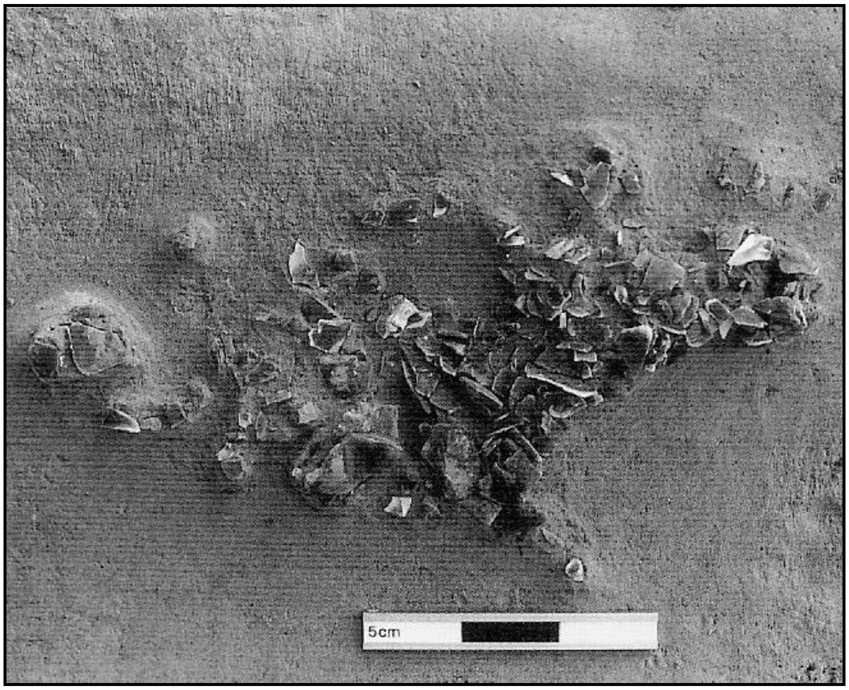

Figure 4.8 Handaxe reduction scatter from GTP 17
After Roberts and Parfitt (1999a, Figure 286)

Following Parfitt's analysis, the most direct evidence for hominin interaction within the wider palaeocommunity is in the form of modified large/medium-sized mammal bones (Parfitt, 1999a; Roberts and Parfitt, 1999b). Some of the faunal remains clearly represent natural mortality but those with cut marks appear to demonstrate that hominins had access to the carcasses of prime age individuals prior to other predator-scavengers (Roberts and Parfitt, 1999b). Indeed, in some cases predator-scavenger modification has been recorded *overlying* hominin modification. Furthermore, evidence suggests that these hominins were fully exploiting these carcasses for muscle meat and other resources such as the bone marrow, tongue, and brain (Roberts and Parfitt, 1999b). Discrete lithic scatters, prior access to these carcasses and holistic resource exploitation have been used to suggest a primary role for hominins in the accumulation of the butchered faunal assemblage (Roberts and Parfitt, 1999b). Additional evidence of an 'impact point' on a horse scapula has been used to suggest a hominin subsistence strategy based on either active hunting, confrontational scavenging at other carnivore kills or a combination of both (Roberts and Parfitt, 1999b).

The Pleistocene sediments at Boxgrove illustrate the transition from the terminal interglacial (Slindon Formation) into the ensuing glacial (Eartham Formation). The disused cliff is a constant feature in the landscape. The chalk cliff provided large quantities of high quality raw material for the production of bifaces for use within an environment, to the south, that changed dramatically throughout the existence of the site (open shore, mudflats, grassy plain, marsh). The depositional environment of the Slindon Formation facilitated the quick burial and preservation of large quantities of Lower Palaeolithic tools and faunal material. The large exposures of fine-grained Pleistocene deposits at Boxgrove have offered a unique insight into the changing climates and environments at this site during the Middle Pleistocene. The nature of these deposits and condition of the materials has allowed for a more detailed analysis of hominin behaviour within this evolving landscape and the wider palaeocommunity

4.3 Hoxnian Interglacial (MIS 11)

4.3.1 Swanscombe

Barnfield Pit, Swanscombe (Kent), has been the site of geological and archaeological research since the turn of the 20th Century (Roberts *et al.*, 1995). The site was one of the earliest in the UK where flint tools and bones were discovered in the same deposit (Smith and Dewey, 1913; cf. Conway *et al.*, 1996). The site was initially recognised as important because not only could it be positioned within a regional geological framework but the stratified flint industries conformed to the evolutionary models that were being developed in mainland Europe (Conway *et al.*, 1996). Swanscombe is perhaps most famous for the three refitting human skull fragments (occipital and parietal) assigned to *Homo cf. heidelbergensis/ neanderthalensis* (Overy, 1964; Stringer and Gamble, 1993). Using mammalian biostratigraphy the site has been dated to c. 400kyr and positioned within the Hoxnian interglacial (MIS 11; c.423-380 kyr bp) (Schreve, 1996, 2004b). Throughout the 20th Century major excavations were undertaken at the site by; Dewey (1912-1914), Marston (1937); Wymer 1955-60; and Waechter (1968-72) (See Conway *et al.*, 1996, for full description). Although other collectors recovered large quantities of material, they were frequently excavated unsystematically and the provenance of finds is often incomplete or unknown. The faunal assemblage used for this thesis was recovered during Waechter's excavations, which is better sourced and documented than others (Conway *et al.*, 1996; Schreve, 1996).

Location and stratigraphy

Barnfield Pit, Swanscombe, Kent is a former chalk pit situated on the southern flank of the Lower Thames basin, 5km east of Dartford (Figure 4.9). The geological sequence of the Pleistocene deposits has been known since early work by Smith and Dewey (cf. Conway *et al.*, 1996) and subsequent accounts were usually re-worked from previous research with no overall investigation into the structure of the beds until Waechter's excavations (Waechter, 1968, 1969). The Swanscombe deposits comprise gravels, sands and loams (Conway *et al.*, 1996) and are sandwiched between the Lower and Upper Orsett Heath gravels, which correlate with the Boyn Hill Formation of the Middle Thames (see Figure 4.10) (Gibbard, 1985). Previous work has highlighted that the Anglian glaciation diverted the course of the River Thames southwards to its present course (Bridgland, 1994; Preece, 1995). During the terminal part of the Anglian Glaciation the Thames cut a wide shallow channel, running east to west, into the Chalk to the north and Thanet Sand to the south. The deepest part of the channel is at 23m OD and rises to about 33.6m OD at the southern margin (Conway *et al.*, 1996). The channel was subsequently infilled by fluvial sands and gravels that represent the earliest post-Anglian course of the River Thames. These deposits have been divided into six local stratigraphic units (see Figure 4.11 and Table 4.2).

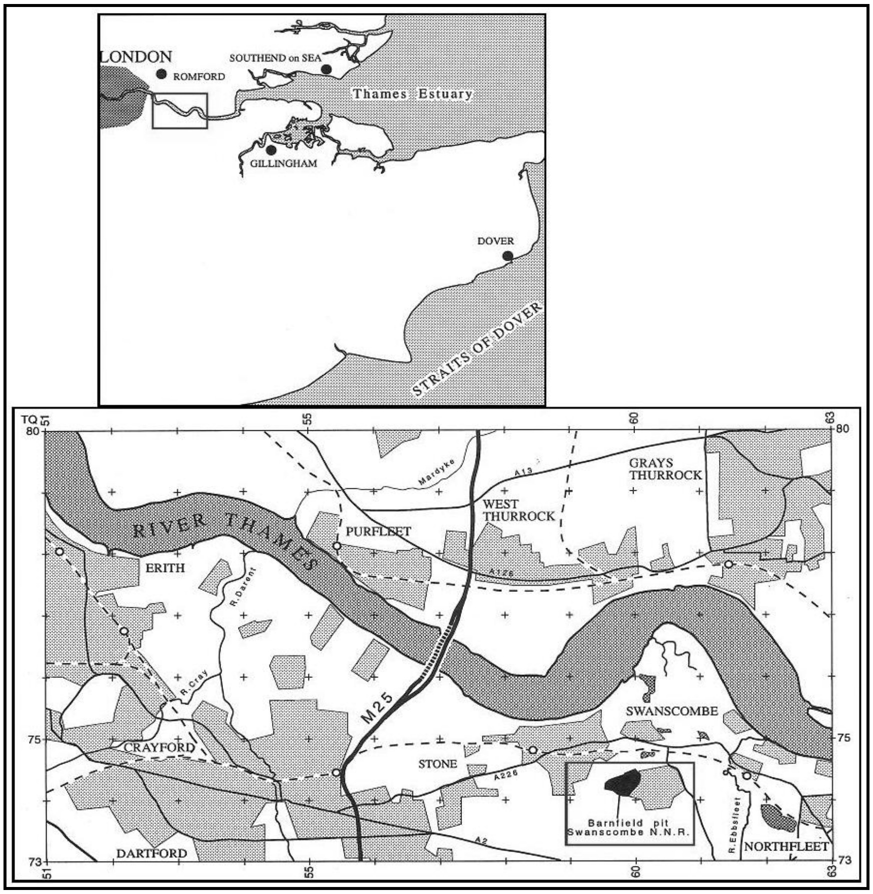

Figure 4.9 Location of Barnfield Pit, Swanscombe
Modified from Conway et al (1996, Figure 1.1)

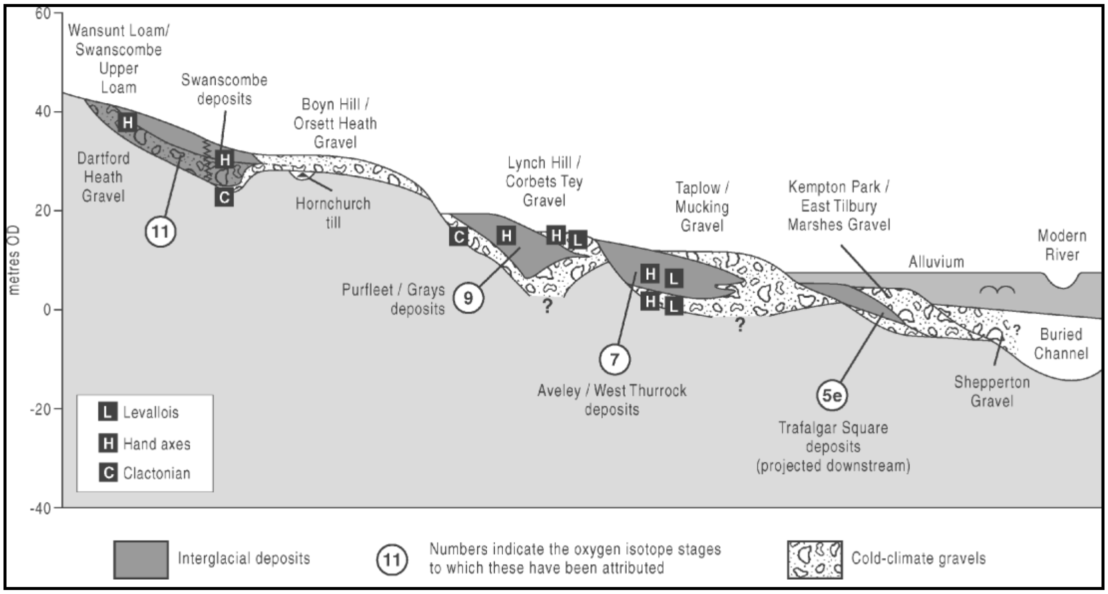

Figure 4.10 Idealised transverse section through Lower Thames
Showing Swanscombe in relation to the interbedded cold and warm climate deposits and the stratigraphic position of Palaeolithic industries; Modified from Bridgland *et al* (2006, Figure 2)

	Unit	Composition	Climate	MIS
	Higher Loam	Poorly understood		
	Upper Gravel	Clay with pockets of coarse, angular gravel. Evidence for perglaciation at boundary with upper loam	Cold	
	Upper Loam	Poorly bedded, massive silty clay. Possible fluvial overbank sediments (?).	temperate	11a
	Upper Sand	Fine loamy sand with silty clay seams and ice wedges and cryoturbation.	Cold	11b
Middle Gravel	Middle Gravel	Fluvial aggradation and reworking	Cooler	11c
	Lower Middle Gravel		temperate	
Lower Loam	Lower Loam undifferentiated	Low energy deposition with still or stagnant water. Occasional channel cutting perhaps indicative of increased flow. Temporary dry land surfaces with desiccation features.	temperate	
	Lower Loam weathered surface			
	Weathered Lower Loam			
	Lower Loam main body			
	Lower Loam sandy horizon			
	Base of Lower Loam			
Lower Gravel	Lower Gravel Midden	Reworking of gravel and fluvial aggradation	Warm	
	Lower Gravel (units 1-3)			
Basal Gravel		Lines the base of the channel and consists of poorly sorted, unbedded flint gravel	cold/warm	

Table 4.2 Summary of Hoxnian deposits at Swanscombe and their climate designation
Modified from: Conway *et al* (1996), Roberts *et al* (1995), Schreve (2004b)

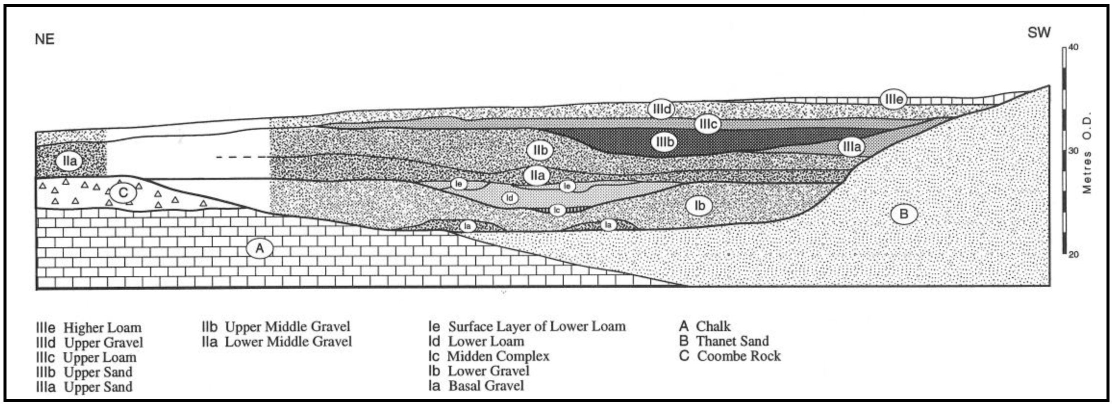

Figure 4.11 Schematic geological section of Swanscombe deposits
After Conway *et al* (1996, Figure 8.1)

The basal deposit consists of the Lower Gravel which contains a soliflucted component at the base of the unit, which was probably deposited during the final stage of the Anglian Glaciation. The Lower Gravel is a medium/coarse, horizontally-bedded sandy gravel which varies in thickness from 0.1 to 2.9m (Conway *et al.*, 1996). In places the Lower Gravel is sub-divided into three layers based primarily on the colour. Apart from the very base of the Lower Gravel the majority of this horizon represents fluvial reworking and aggradation indicative of a fast flowing river environment. Towards the top of the Lower Gravel Waechter identified a 'Midden deposit' which he interpreted as evidence for the accumulation of faunal and lithic material by human activity (Conway, 1996). This unit is discussed further in later sections and chapters of this thesis (see below and chapter 7). The molluscan and mammalian data throughout Lower Gravel indicate fully interglacial conditions (see below for more detail).

The Lower Loam was deposited in a channel, approximately 200m wide and aligned SW-NE, cut into the surface of the Lower Gravel to a depth of 2.5m (Schreve, 2004b). The deposit is characterised by fine, yellow-buff/brown sandy to clayey loam (Conway *et al.*, 1996). The Lower Loam illustrates a variation in thickness from 0.1 to 2.4m, whilst in some areas the deposit has been pinched out. Clearly, the finer grained deposits contrast with the underlying coarse gravel deposits and indicate a change in depositional regime with a return to a slower/more gentle flow. Within the loam, several stages of channel recutting have been identified along with temporary dry land surfaces as identified by weathering horizons (Conway *et al.*, 1996). The ostracod and mollusc data from the Lower Loam also demonstrate significant variation and changing flow rates from clear running water to more stagnant conditions (Robinson, 1996) perhaps indicating the migration of the river system across the flood plain. The Lower Loam might represent an abandoned meander channel margin or a river section that was only intermittently connected to the main system (Robinson, 1996). At its surface, the deposit is truncated by gravel deposits indicating a change in fluvial activity with a return to faster flowing conditions.

The Middle Gravels have been subdivided into the Lower and Upper Middle Gravels based on variation in sedimentation throughout the horizon (Conway *et al.*, 1996). The Lower Middle Gravel comprises a sandy gravel overlain by the cross bedded sands of the Upper

Middle Gravel, both of which indicate a return to fluvial aggradation. The molluscs recovered from the Middle Gravels continue to indicate a warm interglacial climate. More specifically, the terrestrial molluscs from the Lower Middle Gravel suggest a wooded environment whilst those in the Upper Middle Gravel indicate a shift to more open conditions perhaps indicating a cooling of the climate. All the units from the Lower Gravel to the Upper Middle Gravel were deposited under interglacial conditions. Mammalian biostratigraphy (see below), along with amino acid ratios, suggest a chronological attribution to MIS 11 (c.423-380 kyr) (Bowen *et al.*, 1989). In contrast, the surface of the Upper Middle Gravel displays evidence of cryoturbation and is overlain by solifluction material, which suggests cooler climatic conditions. Similarly, the fluvial Upper Sand appears to indicate deposition under periglacial conditions (Conway *et al.*, 1996).

Conway (1996) argued that the Upper Sand, Loam and Gravel represented MIS 10-8 though Schreve (2004b) has challenged this hypothesis using sedimentology, mammalian biostratigraphy and pollen records to argue that the Swanscombe sequence represents a single interglacial (MIS 11). She suggests that the cold-warm-cold sediments indicate oscillations with MIS 11 and not separate isotope stages as suggested by Conway. Thus, Schreve assigns the Lower Gravel, Lower Loam and Middle Gravels to the interstadial MIS 11c and the Upper Loam to MIS 11a. Schreve's revised chronology has been used throughout the faunal analysis and stratigraphic discussion.

Faunal material and palaeoecology

Faunal material has been recovered from most levels within the Swanscombe sequence though the main concentrations were from the Lower Gravel and Lower Loam. The mammalian assemblage represents a fairly standard 'temperate stage' fauna, similar to that from the other Lower Palaeolithic sites (see Boxgrove and Hoxne). The large/medium-sized mammal assemblage includes cervids (*Dama dama*, *Cervus elaphus*, *Megaloceros giganteus, Capreolus capreolus*), bovids (*Bison priscus*, *Bos primigenius*), equid (*Equus ferus*), straight tusked elephant (*Palaeloxodon antiquus*), rhinoceros (*Stephanorhinus hemitoechus*) along with carnivores such as lion (*Panthera leo*), wolf (*Canis lupus*), bear (*Ursus spelaeus*) and a hominin cranium attributed to *H.* cf. *heidelbergensis/neaderthalensis* (Schreve, 1996, 2004b; Stringer and Gamble, 1993).

Although Waechter’s excavations at Swanscombe were more scientific and systematic, than those carried out previously, the mammal fauna recovered is heavily biased towards larger, more readily identifiable specimens (Schreve, 1996). The absence of small mammals, which are important for highlighting small-scale and more localised climatic and environmental change (see Boxgrove), were not extensively collected (Currant, 1996). Despite the absence of vertebrate microfauna, the remaining fauna provide some general information about the palaeoecology of the site.

Although the sedimentary horizons within the basal units of the Lower Gravel appear to indicate deposition during the latter stages of the Anglian Glaciation, mollusc species indicate a more temperate climate (Kerney, 1971). Unfortunately, the quantity of mammalian remains from these units cannot be used to support either interpretation. However, the upper units of the Lower Gravel indicate fully temperate conditions and the abundance of fallow deer suggests the presence of nearby deciduous woodland. Interestingly, supporting taxa such as beaver (*Castor fiber*) and wild boar (*Sus scrofa*), which Schreve (1996) notes as present in the overlying Lower Loam, are absent. The presence of small numbers of water vole (*Arvicola terrestris. cantiana*) further supports the presence of a riparian deposit. The identification of horse (*E. ferus*), bovids, rhinoceros (*S. hemitoechus*) and straight tusked elephant (*P. antiquus*) suggest the presence of open grassland, presumably on the river floodplain. The Lower Loam mammalian fauna includes species such as water vole (*A. t. cantinana*) and fallow deer (*D. dama*), and grazing herbivores such as horse, rhino and bovids. These faunal species indicate a similar environment to the upper units of the Lower Gravel, with a mixture of deciduous woodland and dry grasslands on the floodplain. The mammalian assemblage from the Lower Middle Gravels is scarce and often in very poor condition. Although many of the species such as fallow deer, straight tusked elephant and bovids are similar to the underlying units, suggesting a temperate climate, the paucity of remains prevents any further detailed palaeoecological reconstruction.

Although micorvertebrates were not systematically recovered during excavations (Currant, 1996; Waechter, 1968, 1969) the large/medium-sized mammal assemblage combined with the few small mammals recovered provide a clear palaeoecological context. The species identified suggest the presence of a constantly flowing water source (water vole, beaver) near to the site with open, deciduous woodland (fallow deer, beaver, wild boar) also in close proximity. However, the presence of grazing animals, such as horse, rhino and elephant, also indicates the presence of relatively large, open grasslands presumably on the floodplain. Swanscombe highlights a similar mosaic of environments in proximity to the site as at other Lower Palaeolithic sites (see Boxgrove). Having established the climatic and palaeoecological context, it is now possible to discuss evidence for hominin behaviour at the site.

Evidence for hominins: Palaeolithic archaeology and modified fauna

Lithic tools provide evidence for a hominin presence at Swanscombe and are found throughout the Lower Gravel, Lower Loam and Lower Middle Gravels (Ashton and McNabb, 1996). Initially, two separate lithic industries were identified at the site consisting of a flake and core industry (Clactonian) and a handaxe industry (Acheulian) (Figure 4.12 and Figure 4.13) (see Ashton and McNabb, 1996 for detailed description). The presence of two distinct industries was seen as evidence for separate hominin populations and the identification of handaxes from horizons that were stratigraphically above deposits containing Clactonian artefacts was seen as evidence for population replacement. Indeed, this model of cultural and human evolution meshed well with the evolutionary sequences from Africa, particularly Olduvai (Ashton and McNabb, 1996).

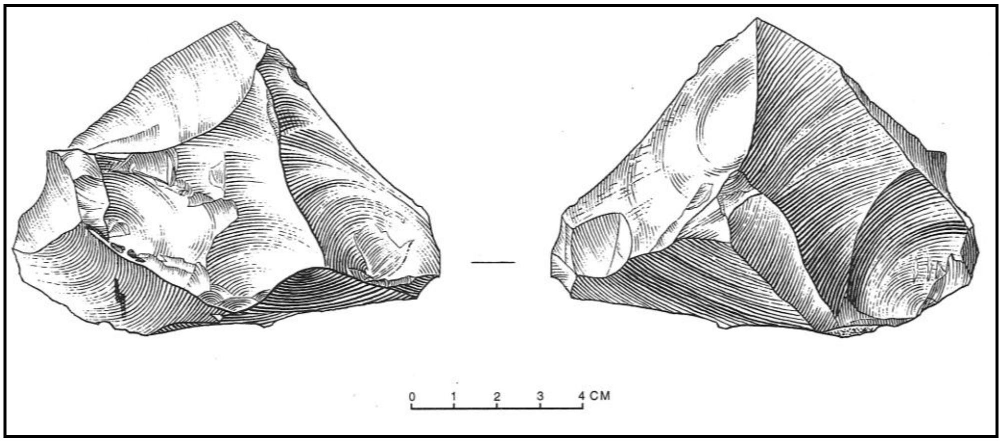

Figure 4.12 Example of core from Lower Loam with single episode complex alternate flaking After Conway *et al* (1996, Figure 16.1)

However, notable excavations at Boxgrove and High Lodge, amongst others, recovered large numbers of handaxes that predated the Swanscombe deposits containing the Clactonian industry (Ashton *et al.*, 1992; Roberts and Parfitt, 1999a). More recently Ashton and McNabb (1996) indentified a handaxe from within the Lower Gravel which appeared to support lithic evidence from other Lower Palaeolithic localities such as Barnham, Suffolk (Ashton *et al.*, 1998), and thus refute the chronological framework for Lower Palaeolithic lithics. Ashton and McNabb (1996) argued that the Clactonian was not a separate industry but that tool manufacture was predicated by the availability and quality of the raw material. However, McNabb (2007) has recently recanted on this previous interpretation and now considers the Clactonian a separate industry.

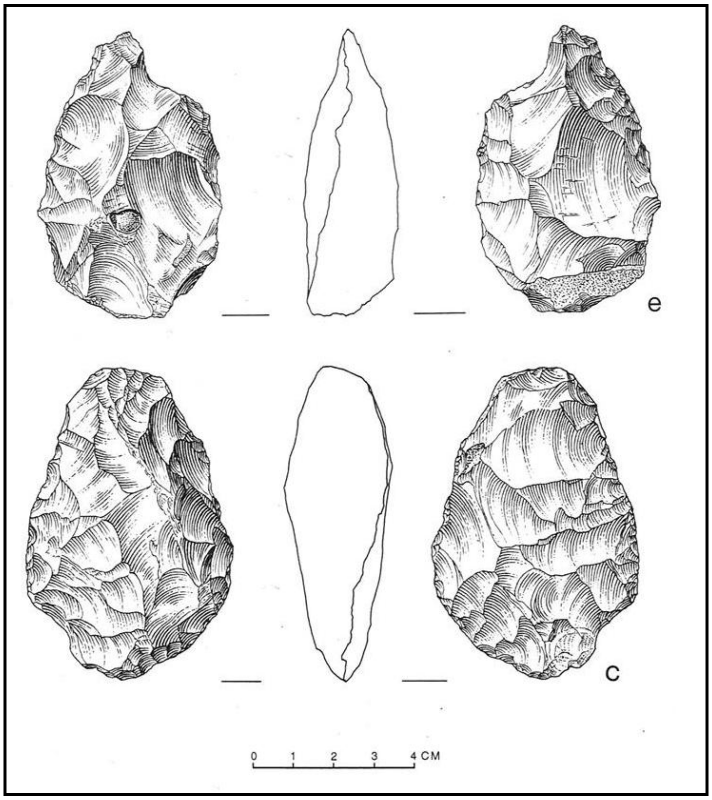

Figure 4.13 Bifaces from Swanscombe; top from Lower Gravel, bottom from Lower Middle Gravel Modified from Conway *et al* (1996, Figures 16.4 and 16.5)

The faunal assemblage recovered during excavation has undergone similar reinterpretation since its initial discovery and description (Waechter, 1968, 1969). Waechter originally interpreted the assemblage as direct evidence of hominin hunting and butchery of various large/medium-sized mammals alongside the river channel (Waechter, 1976). During excavation Waechter identified the Lower Gravel Midden as a unit formed by the deliberate discard of lithic and bone material into slack water within the channel (ibid). The faunal assemblage was reanalysed as part of a wider reassessment of hominin subsistence capabilities, and their importance as agents of site formation, by Binford (1981; 1985; 1987b). Binford highlighted previously unrecorded hominin bone surface modification located on distal long bones and other skeletal regions without large quantities of meat. On the basis of evidence from a tiny part of the assemblage, Binford reassessed previous interpretations of hominin subsistence, portraying instead these communities as passive scavengers (Binford, 1985). Thus, the Swanscombe faunal assemblage has produced two distinctly different interpretations of hominin subsistence behaviour at this site, and both need to be rigorously tested using the outlined methodology outline in Chapter 3.

4.3.2 Hoxne

The site of Hoxne, Suffolk, is of significant archaeological importance as it was here in 1797, that John Frere discovered flint tools and began the process of establishing the antiquity of the human species. Frere discovered “flint weapons” beneath clay that was being dug for bricks, and recognised that the flints being extracted had been shaped by a “…people who had not the use of metals” (Wymer and Singer, 1993b). Hoxne is the type site for the Hoxnian Interglacial *sensu stricto* (MIS 11) and is dated to c. 400 kyr bp, based on its stratigraphic relationship with the basal glacial till (Lowestoft Till), together with its palynological and mammal biostratigraphic signatures. The long history of research at Hoxne, like Swanscombe, has produced a large quantity of faunal material, though much of this is difficult to provenance. The Singer and Wymer excavations (Singer *et al.*, 1993) provide the best recorded and documented faunal assemblage and hence this material was analysed for this thesis.

Location and Stratigraphy

Hoxne is located in Suffolk, 60km from the North Sea coast, near to the River Waveney which divides Norfolk and Suffolk (see Figure 4.14) (Singer *et al.*, 1993). Since its initial discovery by Frere the site has been repeatedly returned to and excavated by both archaeologists and geologists. These deposits were investigated during the 19th Century by Belt (1876), Clement Reid (1888), British Association Committee (1895), and throughout the 20th Century by Reid Moir (1920-34), West (1951-54) and Singer and Wymer (University of Chicago 1972-74, 1978) (cf. Singer *et al.*, 1993), and more recently by

Ashton *et al* (2008) (see Figure 4.15). A composite stratigraphic sequence for the site is illustrated below (see Table 4.3).

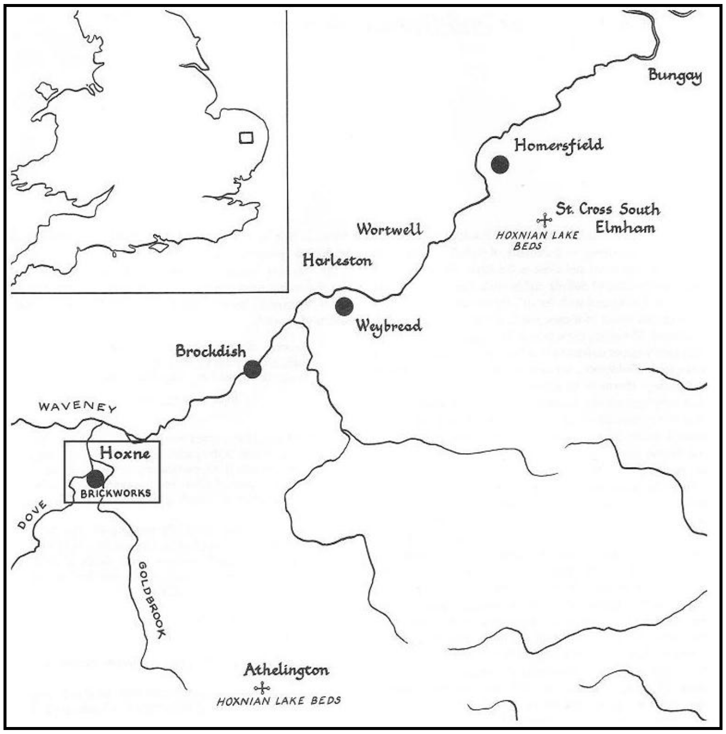

Figure 4.14 Location of the Lower Palaeolithic site at Hoxne in the Waverney valley Circles indicate other known Palaeolithic sites; after Singer *et al* (1993, Figure 1.1)

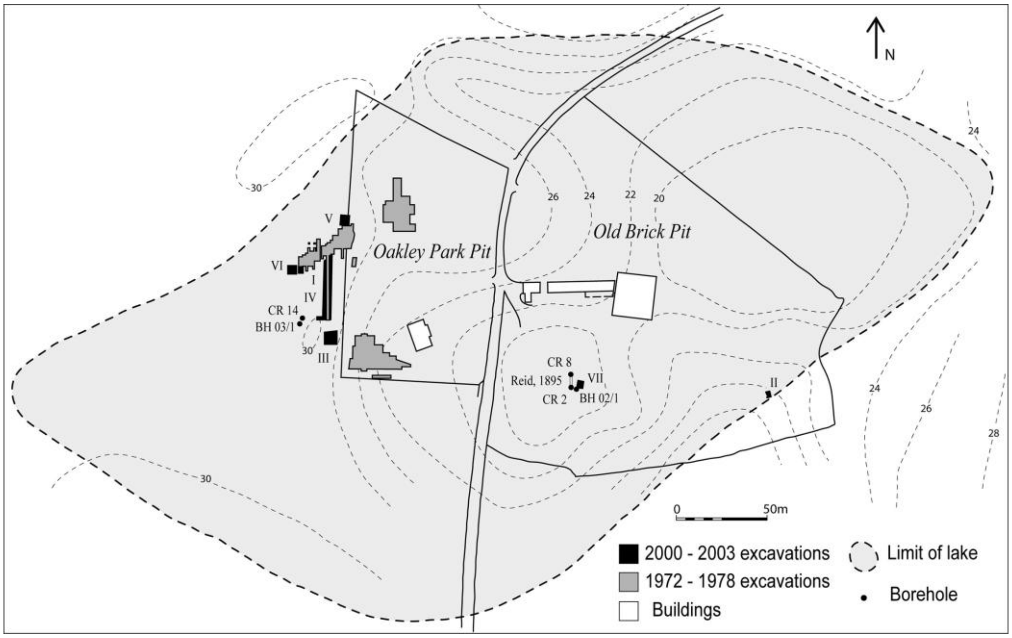

Figure 4.15 Hoxne site plan illustrating major excavations, lake contours and limit of lake After Ashton *et al* (2008, Figure 3)

Current investigation (Ashton *et al.*, 2008) has produced a revised sequence solving some of the confusion in the original monograph (Singer *et al.*, 1993) surrounding stratigraphic relationships (see Table 4.3 and Figure 4.16).

Bed		Description	Climate	Archaeology	MIS
Stratum A1	9 8 7 6 5	coversand	cold		
Stratum A2 (i)		cyroturbated sand and gravel	cold		
Stratum A2 (ii)		solifluction gravel	cold	derived Upper Industry	
Stratum A2 (iii)		alluvial sandy clay	warm	Upper Industry	
Stratum B1	4 3 2 1	fluvial sand, silt and clay	warm	Lower Industry	11a
Stratum B2		fluvial chalky gravel	warm		
Stratum C		lacustrine sands and silts	cold		11b
Hiatus					
Stratum D		peat	warm		11c
Stratum E		lacustrine clay	warm		
Stratum F		lacustrine clay	cool		12
Stratum G		Lowestoft Till	cold		

Table 4.3 Current interpretation of Hoxne stratigraphy
Modified from Ashton *et al* (2008, Table 1)

The basal unit is composed of a flint and chalk rich glacial till (Stratum G) assigned to the Anglian (MIS 12) overlain by lake deposits (Stratum E and F) rich in pollen and beetle data indicating a rapid amelioration of the climate and the onset of interglacial conditions. The lower lake deposit (Stratum F) is thought to have been deposited during the terminal Anglian, though the overlying unit (Stratum E) contains pollen indicative of fully temperate deciduous woodland. These deposits are capped by a peat horizon (Stratum D) interpreted as the drying out of the lake basin and the encroachment of terrestrial vegetation (Ashton *et al.*, 2008). Pollen from the unit is dominated by alder and suggests an alder-carr environment with beetle data suggesting mean summer temperatures between 15-19°C (Coope, 1993).

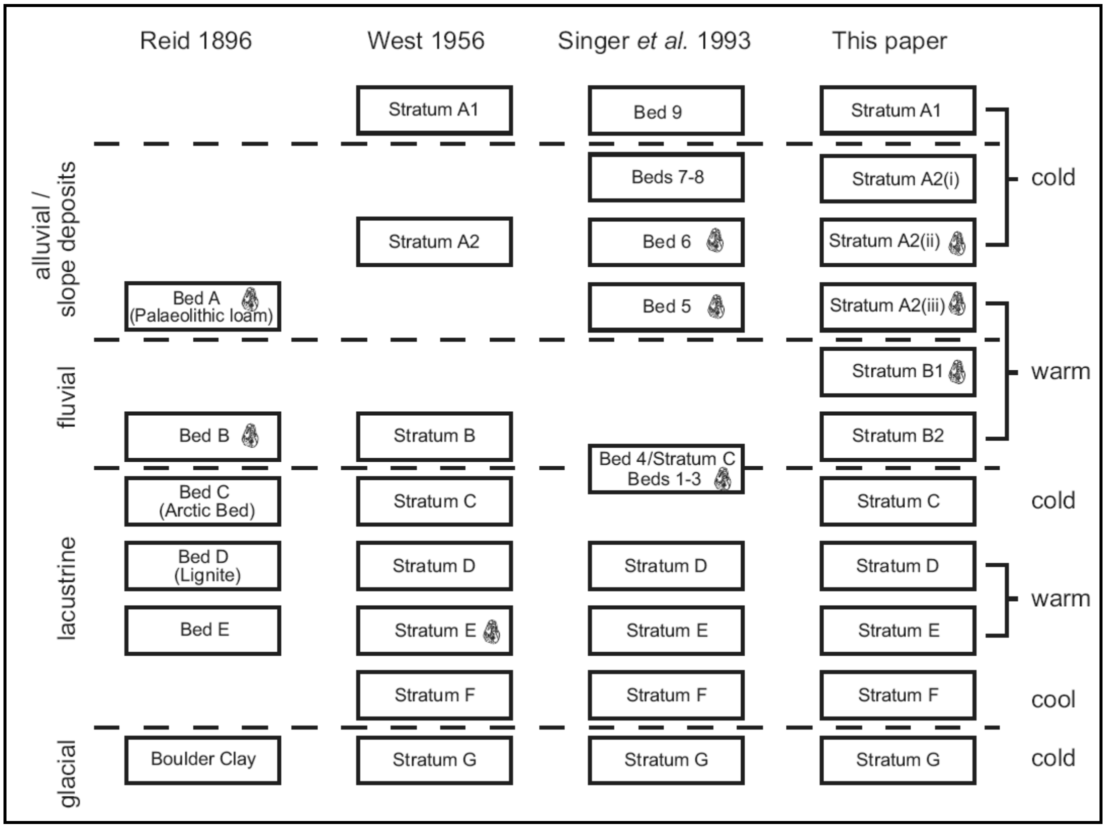

Figure 4.16 Reinterpretation of the Hoxne stratigraphy by Aston *et al* (2008)
Compared with the previous excavations; handaxe symbol shows the contexts in which artefacts were thought to be located; Aston *et al* (2008, Figure 5)

A return to a lacustrine environment is illustrated by the deposition of laminated deposits (Stratum C) combined with an influx of coarser sands and silts, which overlie the basal units (Stratum G-D). Pollen data suggests a warm climate, though this designation is at odds with the plant macrofossils such as dwarf birch and dwarf willow recovered from this horizon (Ashton *et al.*, 2008). The authors note that the macrofossils are fragile and would not have survived reworking and are thus contemporary with the unit (ibid). Combined with beetle evidence, that also suggests a cold climate, the conclusion is that some of the pollen has been reworked into the unit and it is therefore likely that a hiatus in deposition occurred at the site (Ashton *et al.*, 2008). Stratum C is incised by a broad (>30m), shallow (c.2m) channel infilled with bedded sands, silts and clays and previously unrecognised within the sequence (Stratum B2 and B1) (Ashton *et al.*, 2008; Singer *et al.*, 1993). Further analyses of lithic and faunal material from these deposits (Parfitt, pers. comm.) suggest a fluvially influenced accumulation aligned with the NE-SW orientation of the channel. Capping the sequence is Stratum A originally sub-divided into A1 and A2 (see Singer *et al.*, 1993) and subdivided further in current work into A2 (i-iii). The basal sub unit (A2 iii) is an alluvial deposit laid down during a warm environment, whereas the overlying deposits are a solifluction unit (A2 ii) and cryoturbated sands and gravels (A2 i), indicating a return to a colder climate.

The Hoxne sedimentary profile indicates a fluctuating climate within the Hoxnian Interglacial with successive cooling and warming events. The stratigraphy appears to highlight two interstadial events within MIS 11 (Ashton *et al.*, 2008). The first of these (the Hoxnian *sensu lato*) is correlated with the first post-Anglian temperate event in MIS 11 between c425-395 kyr bp (MIS 11c). The later event, named the Oakley Park Interstadial, is correlated with MIS 11a. The intervening cold episode, represented by Stratum C, is assigned to the Goldbrook Stadial which is correlated with Marine Isotope Sub-stage 11b (ibid). The revised stratigraphy has implications for the role of hominin communities at the site (see below and chapter 8).

Faunal material and palaeoecology

Faunal material has been found throughout the deposits at Hoxne with the majority recovered from the base of Stratum C (See Chapter 8 and Stuart *et al.*, 1993). However, it is entirely possible that these remains were originally recovered from the base of the channel feature recently identified (Ashton *et al.*, 2008). Nevertheless, the fauna recovered from the site is similar to assemblages from interglacial deposits at Boxgrove and Swanscombe (Parfitt, 1999a; Schreve, 1996, 2004b). The large-medium sized fauna is composed mainly of equid (*Equus ferus*), cervids (*Cervus elaphus, Dama dama, Capreolus capreolus*) along with rhinoceros (*Dicerorhinus* sp.), and other more exotic species such as macaque (*Macaca sylvanus)*. Alongside the herbivore assemblage is a limited carnivore guild consisting of lion (*Panthera leo*) and bear (*Ursus* sp.). There is a relatively large assemblage of small vertebrates including mammals such as beaver (*Castor fiber*), extinct giant beaver (*Trogontherium cuvieri*), mole (*Talpa minor*), pine vole (*Microtus (Terricola)* cf. *subterraneus*) and lemming (*Lemmus lemmus*), along with numerous species of bird, amphibian and reptile.

The faunal assemblage highlights a similar mosaic of environments to those identified at the other Lower Palaeolithic study sites. The presence of large areas of open grassland is indicated by the occurrence of horse and other grazing animals such as rhino. The proximity to a water source and deciduous, open woodland is attested by the presence of species such as beaver, fallow deer and macaque. The presence of lemming (*Lemmus lemmus*) would seem to indicate a colder climate as their modern distribution is situated in cold, northern latitudes. However, the presence of this species associated with interglacial fauna at other sites (Boxgrove) may indicate a different range and habitat preference to modern populations (Ashton *et al.*, 2008). The mammalian fauna can also be used to provide an estimation of relative age for the Hoxne deposits using the presence of the species *Microtus (Terricola)* cf. *subterraneus*, which appears to have been absent in Britain after MIS 11 (Parfitt, 1998).

Evidence for hominins: Palaeolithic archaeology and modified fauna

Although no hominin fossil remains have been found at Hoxne, numerous lithic tools have been recovered and identified (see Figure 4.17 and Figure 4.18). Wymer and Singer (1993a) provide a detailed description and analysis of these artefacts and divide the assemblage into two industries:

1. *The Lower Industry*: recorded as an "…Acheulean industry with elegant mainly cordate or ovate, handaxes usually sharpened with a tranchet flake" (Wymer and Singer, 1993a, p74). A few secondary flakes are noted along with some cores; these were found within the upper part of the lacustrine clay-muds (Stratum E) but mainly near the base of the fluviatile sediments in Stratum C (Beds 1, 2 and 3).
2. *The Upper Industry*: An "…Acheulean industry with mainly pointed handaxes of varying refinements and numerous elegant scrapers of various forms" (Wymer and Singer, 1993a, p74) with evidence for several cores and the use of anvil technique. The authors record this industry mostly near the top of a brown, silty, floodplain deposit (Bed 5).

The presence of two technological distinct lithic industries on one Lower Palaeolithic site has occurred at other UK sites (see Swanscombe above). Several of the flakes have been reworked or been additionally modified, which has been seen as evidence for technological variety (Wymer and Singer, 1993a). Evidence of hominin modification of the faunal material was identified though it was not possible to make definitive conclusions about the role of hominin communities (See Stopp, 1993 for more detail).

Evidence for a hominin presence in the vicinity of Hoxne has been demonstrated by the large quantity of lithic artefacts and some limited evidence for direct modification of the fauna. Although the typology of the lithic assemblage has not altered since initial identification, the position of these artefacts within the stratigraphic sequence has changed (see Table 4.3 and Figure 4.16). Wymer and Singer (1993a) recorded the Lower Industry mainly from the base of Stratum C with the Upper Industry from the top of Bed 5. Ashton *et al.* (2008) recorded no archaeological material in Strata F-D, and document the Lower Industry at the base of the channel feature (Stratum B1) whilst the Upper Industry is recovered from Stratum A2 (iii) and in a derived context from Stratum A2 (ii). Importantly, evidence for hominin occupation post dates the cold event categorised by the so-called ‘Arctic Bed’ of Stratum C (Singer *et al.*, 1993). Current interpretation of the stratigraphic sequence indicates two post-Anglian temperate events (Ashton *et al.*, 2008). The presence of two distinct warm periods within MIS 11, and the correlation of Stratum C with MIS 11b, suggests that the archaeology from the site is later in age than originally thought.

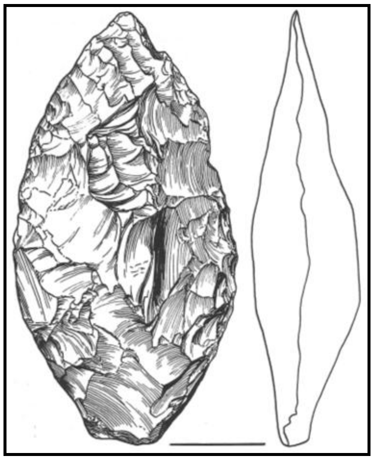

Figure 4.17 Hoxne biface from the Lower Industry
After Singer et al (1993, Figure 4.14)

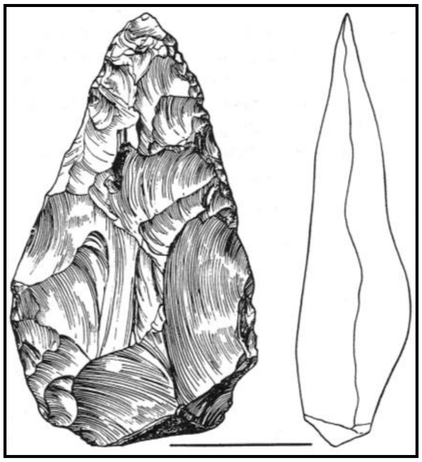

Figure 4.18 Hoxne biface from Upper Industry
After Signer et al (1993, Figure 4.24)

4.4 Devensian (MIS 3)

4.4.1 Lynford

Open air Middle Palaeolithic sites are especially rare in the UK, with some of the best known sites in continental Europe, such as Maastrict Belvedere, Netherlands and Walletheim, Germany (Gamble, 1999; Gaudzinski, 1996, 1999). In Britain, a considerable quantity of material has been recovered from river terraces, particularly in the Lower Thames (e.g. Aveley, Lion Pit, Purfleet) (Schreve, 2004a; 2004b). The site of Lynford was discovered in 2002 and provides one of the best preserved late Pleistocene faunal and lithic assemblages. The datasets available have allowed for a more detailed palaeoenvironmental reconstruction and analysis of hominin behaviour to be made for this time period (Boismier, 2003; Schreve, 2006). Two radiometric age estimations have been obtained from the site using optically stimulated luminescence (OSL) of channel sediments and produced dates of 64, 000 ± 5000 and 67, 000 ± 5000 yr BP (Boismier, 2003; Schreve, 2006). These figures place the channel sediments at the boundary of MIS 4 and 3, although comparative mammal biostratigraphy correlates the site to MIS 3 (Currant and Jacobi, 2001; Schreve, 2006, in press).

Location and Stratigraphy

Lynford is situated in a disused quarry in south-west Norfolk, 2km north-east of the village of Mundford and 500m to the south-east of the village of Ickburgh (Boismier, 2003) (see Figure 4.19). The site is located on the southern edge of the River Wissey floodplain, with the area sloping towards the north-west and elevations ranging between 12-15m OD. The quarry consists of a c.1.20ha rectangular area between the River Wissey to the north and a flooded former pit to the west (ibid). The site comprises the surviving eastern end of a major palaeochannel filled with organic deposits, situated in the north-eastern area of the site (see Table 4.4). The palaeochannel is orientated in an east-north-east to west-south-west direction, it is approximately 21m in length and has a maximum width of 12m and probably represents a meander cut-off acting as a small basin or oxbow lake, (Boismier, 2003, in press-a; Schreve, 2006, in press)

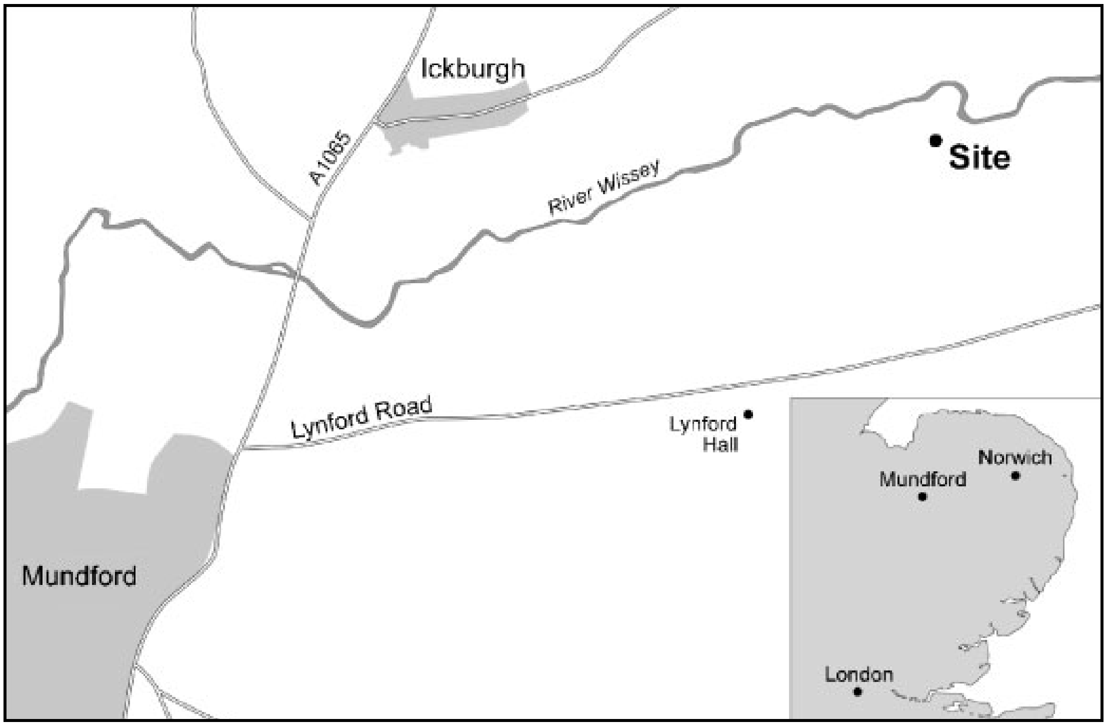

Figure 4.19 Location of Lynford Quarry
Inset shows regional position); after Schreve (2006, Figure 1)

The Chalk (Upper Cretaceous) bedrock is immediately overlain by a suite of fluvial sand and gravel deposits that are contained within a series of palaeochannels extending from the surface of the chalk to the basal deposits of the main palaeochannel. OSL dating of the basal horizons indicate an Early Devensian (83,000 ± 8000 BP) age for these deposits.

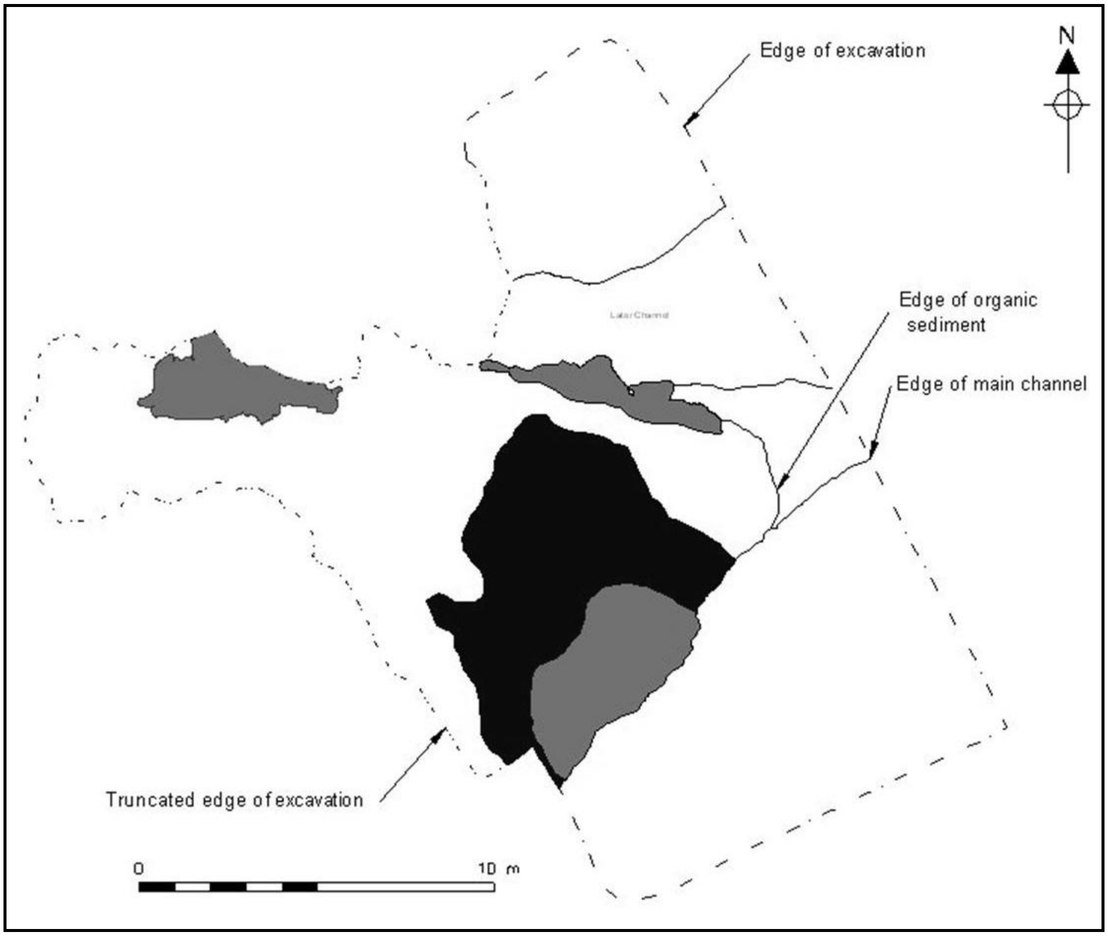

Figure 4.20 Plan of organic deposits at Lynford
Shaded areas represent areas of bank collapse and sediment gravity flow; after Boismier (in press-b), used with permission

Extensive stratigraphic work identified numerous contexts which have subsequently been grouped into various facies associations (Boismier, in press-a). The main palaeochannel deposits are divided into three component facies associations, B-i, B-ii, and B-iii each representing distinct depositional phases in the sedimentary history of the channel (Table 4.4 and Appendix 3 Table 1). The basal deposit (B-i) is sub-divided into three units (B-i:01, B-i:02, B-i:03) and comprises a sequence of gravel, sand and silt facies, indicative of a succession of longitudinal bars both in-channel and along the channel margins prior to channel abandonment. These units point to deposition under low energy or slowly flowing water conditions, often with the presence of ripple laminae within the deposits (Boismier, in press-a).

Component	Subdivision	General Environment
Association B-iii		Oxbow lake environment with slow flow conditions and occasional inputs of higher energy
Association B-ii	B-ii:04b	Oxbow lake environment with slow flow conditions and occasional inputs of high energy flow and evidence for localised bank collapse and sediment gravity flows.
	B-ii:04a	
	B-ii:03e	
	B-ii:03d	
	B-ii:03c	
	B-ii:03b	
	B-ii:03a	
	B-ii:02	High energy influx possibly indicating reconnection to the river system. Return to slow energy regime towards the top of the unit along with localised bank collapse.
	B-ii:01	Low flow regime with periods of sub-aerial exposure.
Association B-i	B-i:03	Low flow conditions prior to channel abandonment.
	B-i:02	
	B-i:01	

Table 4.4 Summary of Lynford stratigraphy and general environment
Modified from Boismier (2003; Boismier, in press-a)

Association B-ii is composed of gravels, sands, organics and silts that indicates fluvial deposition under similarly still or slow-flowing water conditions (Boismier, in press-a) (Table 4.4). Prior to abandonment of the channel, bank sediments and materials were incorporated into the fluvial sediments; micromorphological work has also identified periods of sub-aerial exposure. Association B-ii has been subdivided into four units (B-ii:01, B-ii: 02, B-ii:03, B-ii:04). The basal unit (B-ii:01) indicates a similar low flow regime as the underlying Association B-i with periods of sub-aerial exposure. The material has been subsequently modified by sediment gravity flows and bank slumping disturbance (Figure 4.20). The overlying unit (B-ii: 02) contains coarse sand laminae interbedded with finer sediment, suggesting a high energy influx perhaps indicating that the palaeochannel was not wholly cut off from the main river system. Similar bank slumping and sediment gravity flows have been identified overlying and modifying these sediments post-depositionally. The upper deposits of Unit B-ii indicate a similar slow moving, low energy depositional environment with occasional inputs of flowing water and localised bank collapse (Figure 4.20). These episodes of bank collapse and sediment flow may have resulted from natural degradation and animal induced collapse (ibid). The top of the unit indicates an episodic return to flowing water conditions with most of the deposits exhibiting grain size and structures indicative of still to slow flowing water conditions. It is suggested that the periodic flow relates to influxes of seasonal rainfall and the breakup of winter ice as suggested by dropstones within the deposit (Boismier, in press-a).

The uppermost phase of channel infilling is represented by Association B-iii which comprises of a series of point bar sediments formed along the meander in the channel. The structure of this deposit suggests slowly flowing water alternating with periods of higher energy water flow and/or flood events. Again this stratigraphy could possibly be the result of seasonal meltwater or rainfall associated with the cold climate.

The Lynford channel stratigraphy indicates a slow moving body of water possibly within an oxbow lake environment. Organic deposits have preserved plant macrofossils, which indicate a marshy environment dominated by sedges on the channel margins (Boismier, 2003). A wide variety of fish remains including three-spined stickleback and perch along with common frog and aquatic beetles suggest a reedy environment. The presence of dung and carrion beetles within the deposits indicate the use of the channel by animals and the presence of animal carcasses (Coope, in press). The pollen assemblage is dominated by grass pollen with low counts for trees and shrubs and is indicative of cool, open grassland with small stands of birch trees. Initial temperature estimates, based on the beetle assemblage (Coope, in press), suggest a mean summer temperature of around 13°C and winter temperatures as low as -10°C. Set within these palaeoenvironmental contexts, the sedimentological data can be interpreted as the gradual infilling of a disused river channel as part of an oxbow lake.

Faunal material and palaeoecology

Faunal material was recovered throughout the sequence though the main concentration was recovered from Association B-ii (Boismier, 2003, in press-a; Schreve, 2006, in press). The vertebrate assemblage is dominated by cold or cool adapted herbivore species typical of the Pin Hole MAZ (Mammal Assemblage Zone) of the Middle Devensian (Currant and Jacobi, 2001; Schreve, 2006). The faunal assemblage includes mammoth (*Mammuthus* *primigenius*), woolly rhinoceros (*Coelodonta antiquitatis*), reindeer (*Rangifer tarandus*), horse (*Equus ferus*), bison (*Bison priscus*) and numerous carnivores including wolf (*Canis lupus*), hyaena (*Crocuta crocuta*) and bear (*Ursus arctos*) (Schreve, in press; Smith, unpublished). The assemblage indicates a 'cold stage' fauna which Guthrie (1984; 2001) has described as 'mammoth steppe fauna'.

Evidence for hominins: Palaeolithic Archaeology and modified fauna

Neanderthals are indentified at the site by the presence of lithic tools though no fossil remains were recovered. Most of the artefacts illustrate no evidence for abrasion and are in mint/near mint condition with only a limited number exhibiting evidence of fluvial abrasion (see Figure 4.21). The lithic assemblage falls within the Mousterian of Acheulean Tradition (MTA), and is composed predominantly of handaxes, flakes and microdebitage with lower frequencies of cores and flake tools and the complete absence of Levallois material (Boismier, 2003). The handaxes from the site include pointed, ovate and *bout coupé* forms with a few broken scrapers, notch and denticulate tool types. Only a single lithic refit has been identified, along with a possible quartzite hammerstone and anvil (Boismier, 2003).

Figure 4.21 Middle Palaeolithic biface from Lynford
Picture by K Emery (used with permission)

The absence of fluvial abrasion suggests limited fluvial disturbance and modification. Clearly some post depositional disturbance has occurred as indicated by thin edge damage to the tools. The location of the lithics in chronologically discrete deposits suggests that the channel had been visited by hominins on numerous occasions (Boismier, 2003). In addition, only part of the production sequence (*chaine opératoire*) is represented at the site; the absence of primary flakes indicates that decortification and the production of primary blanks occurred elsewhere (Boismier, 2003). The presence of hominins at and around the site is attested to by the presence of knapped lithic debris. The size of the faunal assemblage and quality and quantity of palaeoenvironmental data allows for a detailed study of hominin behaviour within the palaeocommunity to be reconstructed.

4.5 Overview

The four study sites selected represent some of the best excavated and researched British Palaeolithic sites. All are open air sites and influenced by similar taphonomic processes. These sites were selected because, at some point, each faunal assemblage has been used to support a particular interpretation of hominin subsistence behaviour. At each, it is vital to test the *a priori* assumption that the lithics and modified fauna are associated and whether the proposed models of past hominin meat-procurement behaviour are valid: if the association cannot stand up to taphonomic rigour then the faunal assemblages at these sites need reinterpreting. Boxgrove and Lynford have been excavated recently and have produced a vast quantity of lithic, faunal and palaeoenvironmental data, and both sites provide perhaps the best opportunity to fully understand the site formation events, palaeoecology and the role of hominins in the taphonomic processes operating within these landscapes (Pope and Roberts, 2005). The following chapters will now provide detailed description, analysis and interpretation of the faunal assemblages from each site, starting with Boxgrove.

Chapter 5 Boxgrove analysis and results

5.1 Species specific preservation and modification

The faunal assemblage analysed during this research comprised a total of 1652 identifiable specimens of which 827 were assigned to species, with certain species such as horse (NISP= 145; 17.5%); red deer (NISP= 121; 14.6%); roe deer (NISP= 121; 14.6%); and cervidae sp. indet (NISP= 358; 43.3%) dominating the assemblage (see Figure 5.1; Appendix 2 Table 1). The remaining assemblage of large-medium sized fauna includes extinct rhinoceros (NISP= 39; 4.7%); elephant (NISP= 1; 0.1%); extinct giant deer (NISP= 8; 1%); bison (NISP= 8; 1%); bovidae sp. indet [probably Bison] (NISP= 11; 1.3%); and fallow deer (NISP= 15; 1.8%). The remaining assemblage (NISP= 825) is composed of specimens that could not be assigned to a definitive species (cattle/horse size, NISP= 3; 0.4%; deer/horse size, NISP=1; 0.1%; deer size, NISP= 18; 16.1%; large mammal, NISP= 365; 44.2%; indet, NISP= 323; 39.2%).

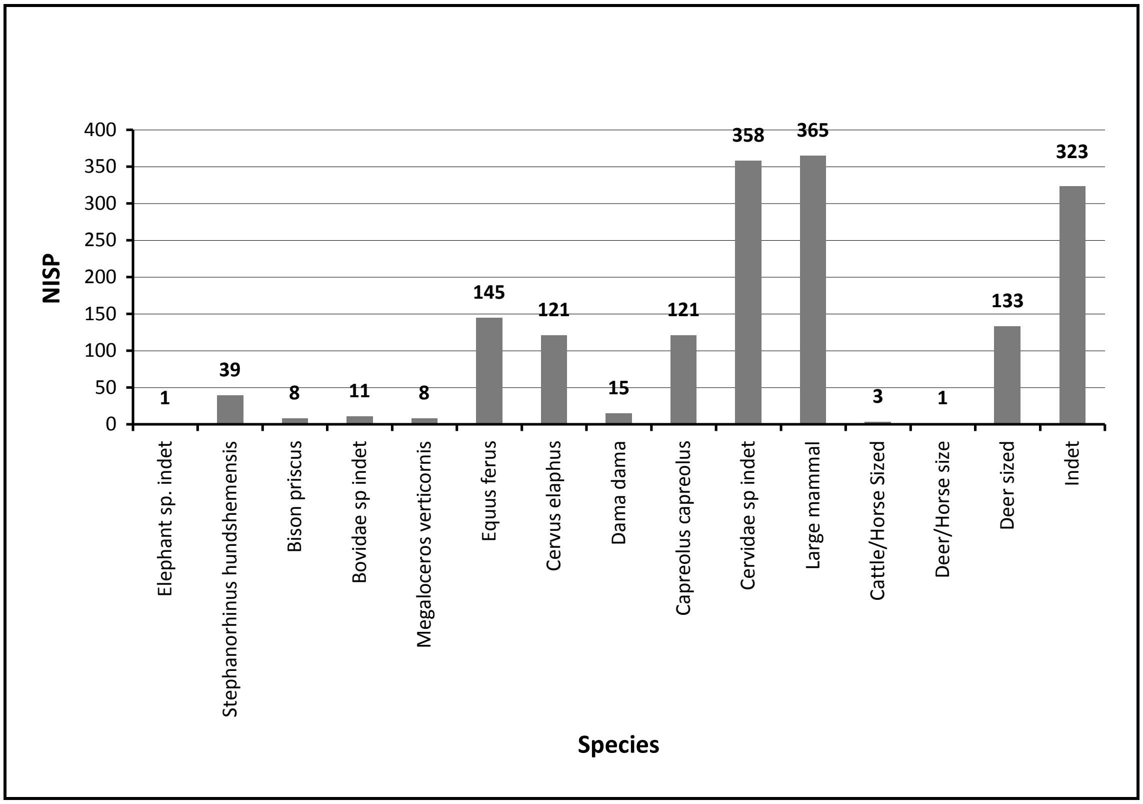

Figure 5.1 Species NISP counts
Arranged by body size from largest to smallest/indet on right

The environmental and sedimentological analyses of the stratigraphic sequence at Boxgrove demonstrate gradual climatic cooling during the latter part of the interglacial immediately preceding the Anglian Glaciation (see Chapter 4; Roberts and Parfitt, 1999a). Faunal remains were recovered throughout the entire stratigraphic sequence although the majority of the faunal remains were recovered from the Slindon Silt, particularly Unit 4b, Unit 4c and Unit 5a (see Appendix 2 Tables 2 & 3; Figure 5.2) A single channel at area Q1/B provided a large quantity of faunal material. The stratigraphy at this location is atypical of the 'standard' Slindon Formation sequence identified (see Chapter 4) across the rest of the preserved Boxgrove palaeolandscape: the faunal composition also appears different, and this phenomenon will be dealt with in more detail below (see Section 5.3.1). The lower density of fauna recovered from certain contexts, such as Unit 3, reflects the depositional environment of these units. Unit 4b marks an hiatus in intertidal mud deposition and it is unknown whether the material recovered from this horizon represents the influx of people into this area across the entire landscape or the gradual encroachment of people during the hiatus. Unit 4c marks the onset of full terrestrial conditions and environments, which were capable of sustaining large herds of herbivores and in this horizon there is an established hominin presence within the wider palaeocommunity.

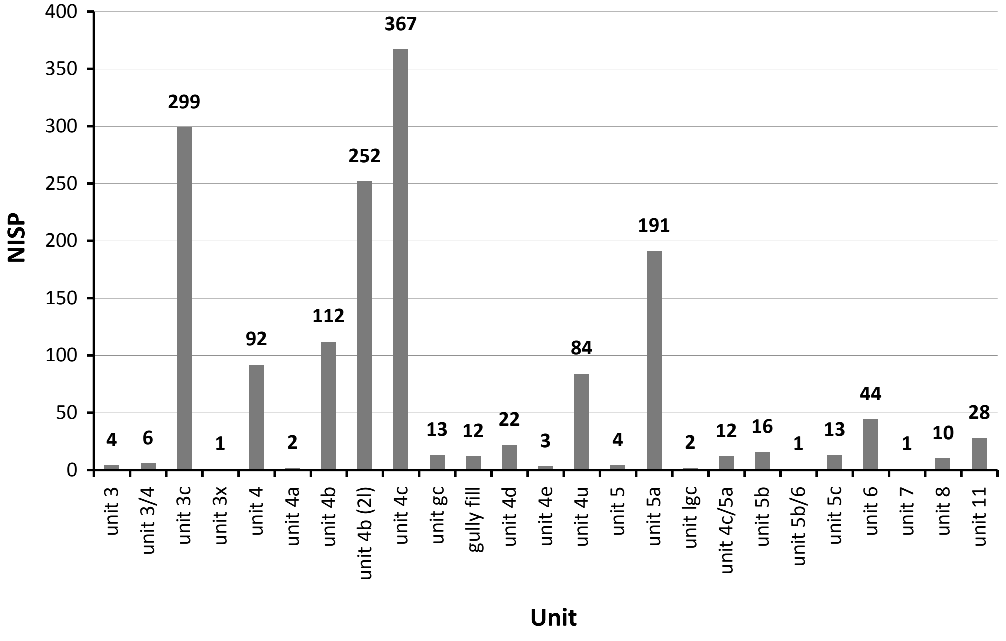

Figure 5.2 NISP counts for major context
note: indeterminate or ambiguous contexts not included see Appendix 2 Table 3

It was expected that the faunal material from the land surface (Unit 4c) would be fragmented because of greater exposure to numerous taphonomic agents such as weathering, trampling, and modification by hominins and other predator-scavengers. Conversely, faunal material from the intertidal deposits (Unit 4b) was expected to illustrate limited fragmentation because of rapid incorporation and burial. However, faunal specimens from these two horizons illustrate very little size difference, and bone material from the intertidal deposits is smaller (see Table 5.1). The small variation in average bone dimensions does not fit the expected bone fragmentation pattern; although the smaller fragments in the intertidal deposits almost certainly results from more intensive use of these carcasses by predator-scavenger and hominin populations. In addition, the dimensions of faunal material from the channel deposits (Unit 3c), which was temporally congruent with the landsurface (Unit 4c), are similar in overall dimensions. Conversely faunal specimens recovered from the overlying cold stage terrestrial deposits (Unit 5a) have dimensions smaller than those documented on bone material from the other major units at Boxgrove. It is possible that this difference relates to a recovery of smaller numbers of specimens from Unit 5a, compared with the other Units. However, it is important to consider whether fragmentation might have resulted from weathering and other natural agents, which are discussed in the following sections.

Unit	Environment	Average length (mm)	Average width (mm)
Unit 4b	Intertidal	52.4	23.4
Unit 4c	Terrestrial	62.0	26.8
Unit 3c	Fluvial	62.4	25.1
Unit 5a	Terrestrial	41.4	18.6

Table 5.1 Average length and width of bone fragments from major contexts

5.2 Weathering

Weathering was recorded across all of the faunal assemblage though the general pattern suggests that most of the material did not remain exposed for long periods of time (using Behrensmeyer, 1978). The majority of the specimens recorded have either suffered relatively minimal exposure (Stage 1= 36.4%; Stage 2= 25.1%) or are unweathered (Stage 0= 27.5%) (see Appendix 2 Table 4; Figure 5.3). Some specimens illustrate longer exposure but these appear to be the exception (Stage 3= 8.7%; Stage 4= 2.3%). The general pattern would appear to indicate that faunal material was exposed for a short time, if at all, before becoming incorporated into the underlying sediments.

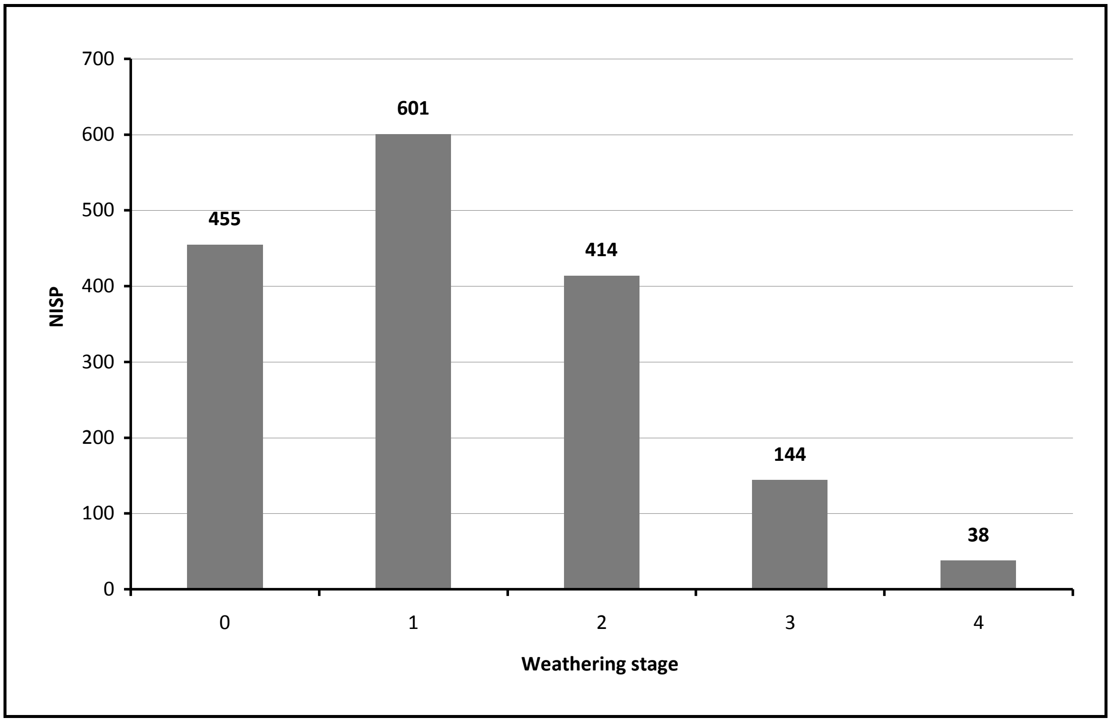

Figure 5.3 NISP count of weathering on Boxgrove fauna Using Behrensmeyer (1978)

The average length and width for all specimens in each weathering stage was calculated and appears to illustrate that specimens that were more highly weathered had, on average, larger dimensions (see Table 5.2). The average dimensions and NISP for each weathering stage suggests that the majority of the faunal assemblage was exposed for a short period of time prior to burial and was not significantly altered either by sub-aerial processes or through re-exposure. Although the assemblage appears fragmented, it has been possible to refit specimens across the site, which suggests that fragmentation occurred prior to burial, either as a result of carnivore or hominin modification, or during burial as a result of trampling.

Weathering Stage	Average Length (mm)	Average Width (mm)
0	35	18
1	48	22
2	68	28
3	73	30
4	111	45

Table 5.2 Average lengths and widths by weathering stage

5.2.1 Weathering by species and context

Species specific weathering correlates with the general weathering pattern. All species were analysed (see Figure 5.4 and Figure 5.5; Appendix 2 Tables 5 & 6), with most specimens recorded as either unweathered (stage 0) or with minimal exposure (stages 1, 2).

Faunal material from Units 4b, 4c and 5a illustrated limited exposure to terrestrial weathering with only larger specimens showing evidence for prolonged exposure. Such similarity in weathering throughout all contexts at Boxgrove does not demonstrate a synchronous depositional event, but perhaps indicates a stable local environment with little discernable seasonal variation and rapidity in the deposition and burial of faunal material, causing the conformity in the observed pattern.

Although the weathering pattern is similar both spatially and temporally the faunal remains do not represent a discrete assemblage but the accumulation of material at different locations and points in time across the changing palaeolandscape. The fragmentation of the assemblage into smaller fragments would have resulted in more rapid incorporation into the sediments, explaining the relative absence of heavily weathered material. Similarly, taphonomic studies of the lithic assemblage have demonstrated, through refitting, that the assemblage is relatively *in situ* and has not suffered significant post-depositional disturbance (Pope and Roberts, 2005; Pope, 2002; Roberts, 1999a, 1999b).

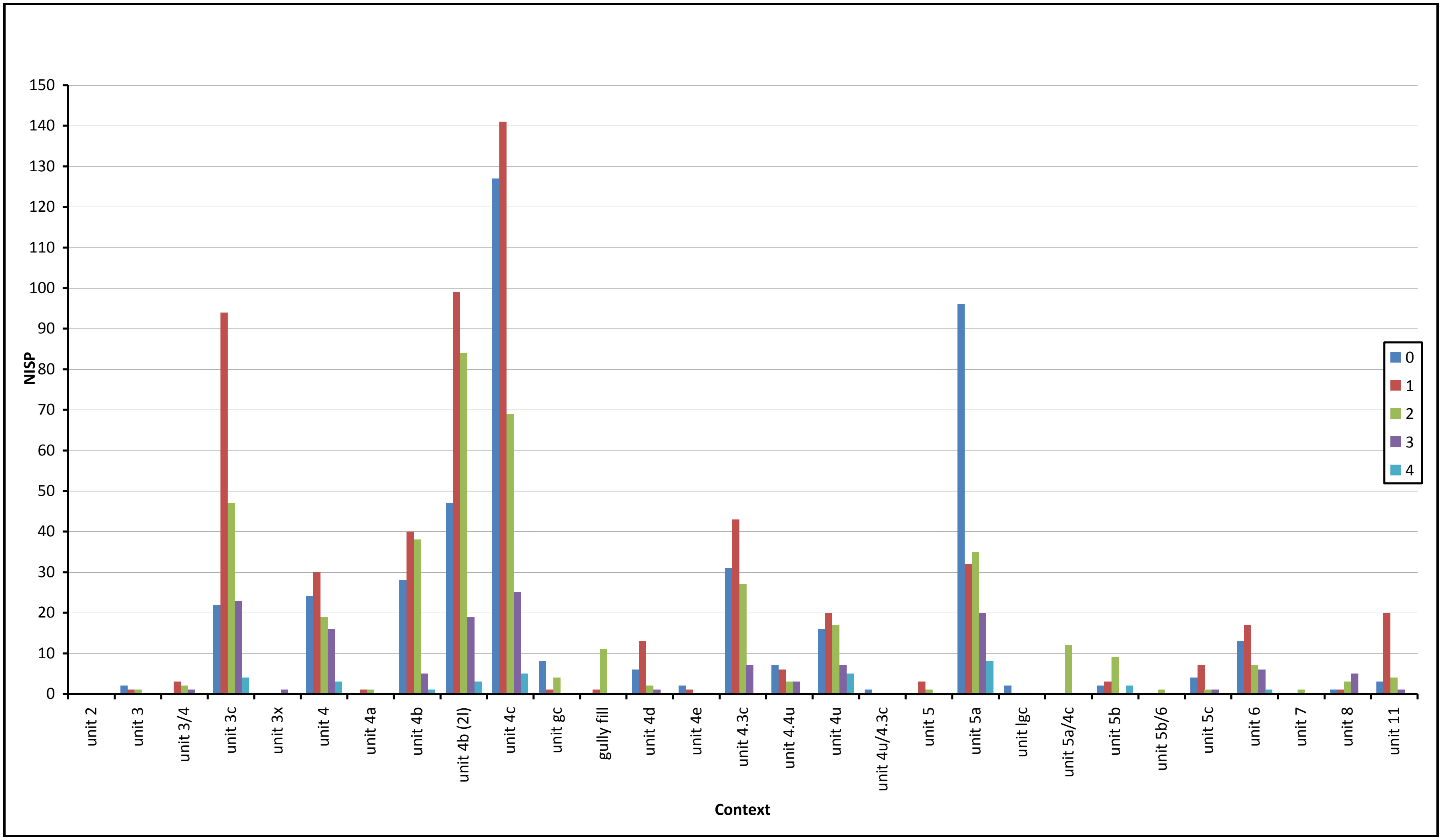

Figure 5.4 Weathering of faunal remains throughout the major Boxgrove contexts
Legend indicates weathering stages as defined by Behrensmeyer (1978)

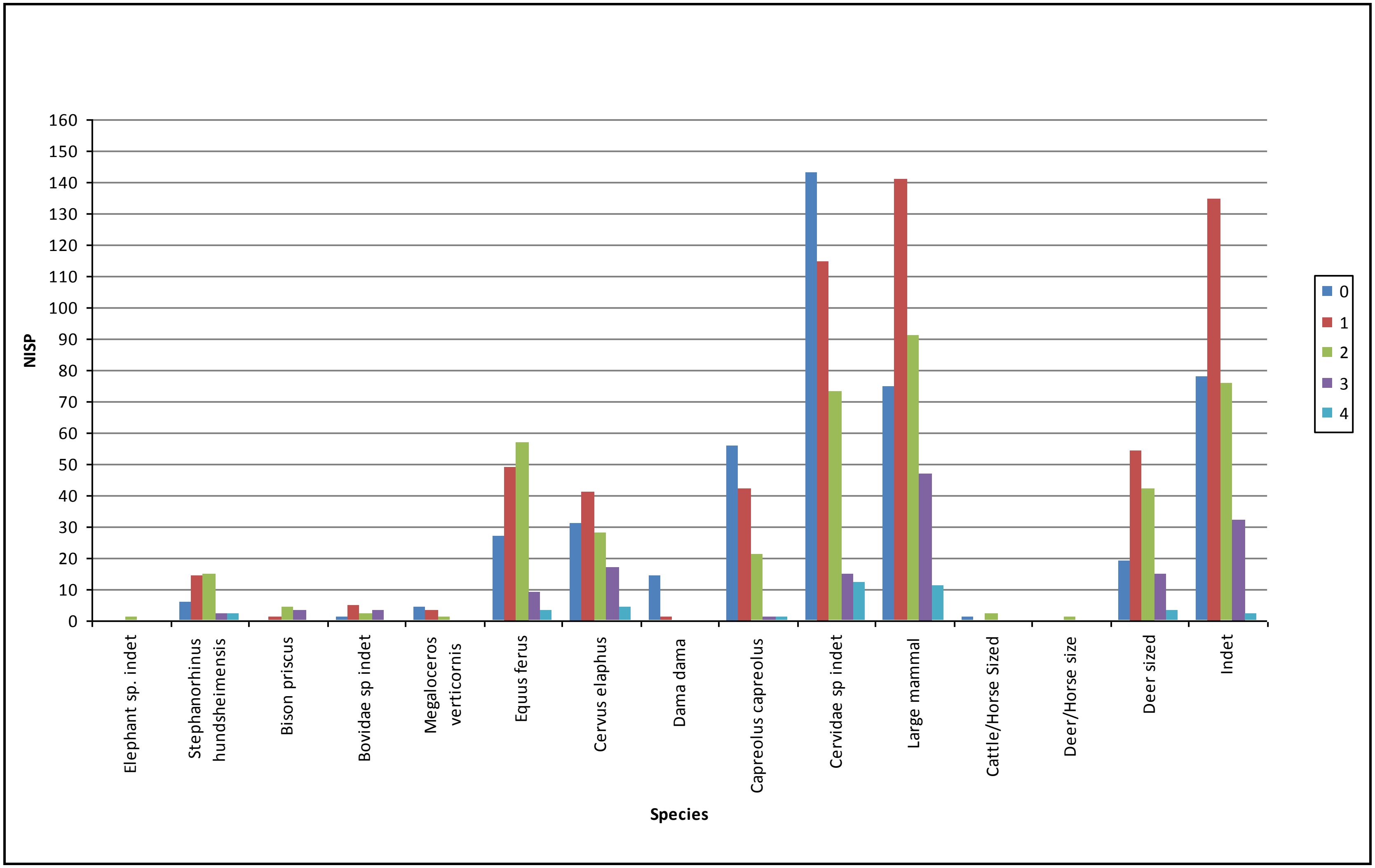

Figure 5.5 Weathering of assemblage by species using NISP counts
Legend indicates weathering stages as defined by Behrensmeyer (1978)

The uniformity of the weathering pattern points to rapid burial at all the points in the landscape investigated. However, within the whole sequence, certain areas, by nature of their depositional sedimentary regime, have had a quicker incorporation of faunal material. The presence of isolated 'events' within the landscape (GTP 17) might also provide a behavioural explanation for the rapid burial of the vertebrate remains, and will be discussed later. Similarly, material from the stream deposits at Q1/B (Unit 3c) indicates a similarly short period of exposure to sub-aerial weathering, which is comparable to faunal remains from the conformable sequence (see Appendix 2 Table 5; Figure 5.4). The rapid incorporation of material into the stream either through the natural stream migration and bank erosion or from carnivore or hominin discard contrasts strongly with material from Swanscombe where faunal remains were not only exposed to terrestrial weathering but also underwent significant periods of fluvial modification and reworking (see Chapter 7).

The faunal material that has accumulated across the palaeolandsurface at Boxgrove has neither been significantly altered by mechanical or chemical action nor suffered significant re-exposure. The excavated faunal assemblages represent the rapid accumulation and burial of this material. Although the faunal remains from Boxgrove are not a truly homogenous assemblage, in temporal terms, the specimens represent an *in situ* accumulation. Weathering has not affected the faunal assemblage in terms of long term exposure, deflation, or re-exposure, further supporting a primary accumulation of material; albeit a palimpsest. The preservation of single episode knapping (Pope and Roberts, 2005; Pope, 2002; Roberts, 1999a, 1999b) and butchery events within the lagoonal deposits (Unit 4b) indicate a relatively rapid depositional environment. The next section utilises the weathering and natural modification data in conjunction with other background information to provide a detailed analysis of the formation, distribution and preservation of the faunal assemblage. Moreover, this will provide the base and context within which the detailed bone surface modification analysis for each species will be considered, and help understand the role of the environment, predator-scavengers and hominins in assemblage formation and modification.

5.3 Other natural modification

Although stone tools are present across the landscape and individual 'knapping events' have been identified (Pope and Roberts, 2005; see below; Roberts and Parfitt, 1999a), it is vital consider the importance of natural agents in the accumulation and modification of the faunal assemblage. Natural modification of the assemblage is recorded throughout all the major terrestrial horizons from the site (see Appendix 2 Table 7; Figure 5.6). Most modification is related either to the weathering of the assemblage (cracking= 48.3%) or modification related to burial or exposure on the land surface (pitting= 42.1%; Scratch marks= 6.9%; Abrasion= 1%). Hydraulic modification is limited (1.7%), with most as a result of moving water in the Q1/B channel deposits, though there is other evidence of modification by water in the Slindon Silts at Quarry 1, as a result of tidal activity (see section 5.3.1; Figure 5.6). The analysis of natural modification agents indicates a limited role in faunal assemblage accumulation. However, the identification of a stream channel along with associated modifications at Q1/B, necessitated further investigation of fauna from these deposits.

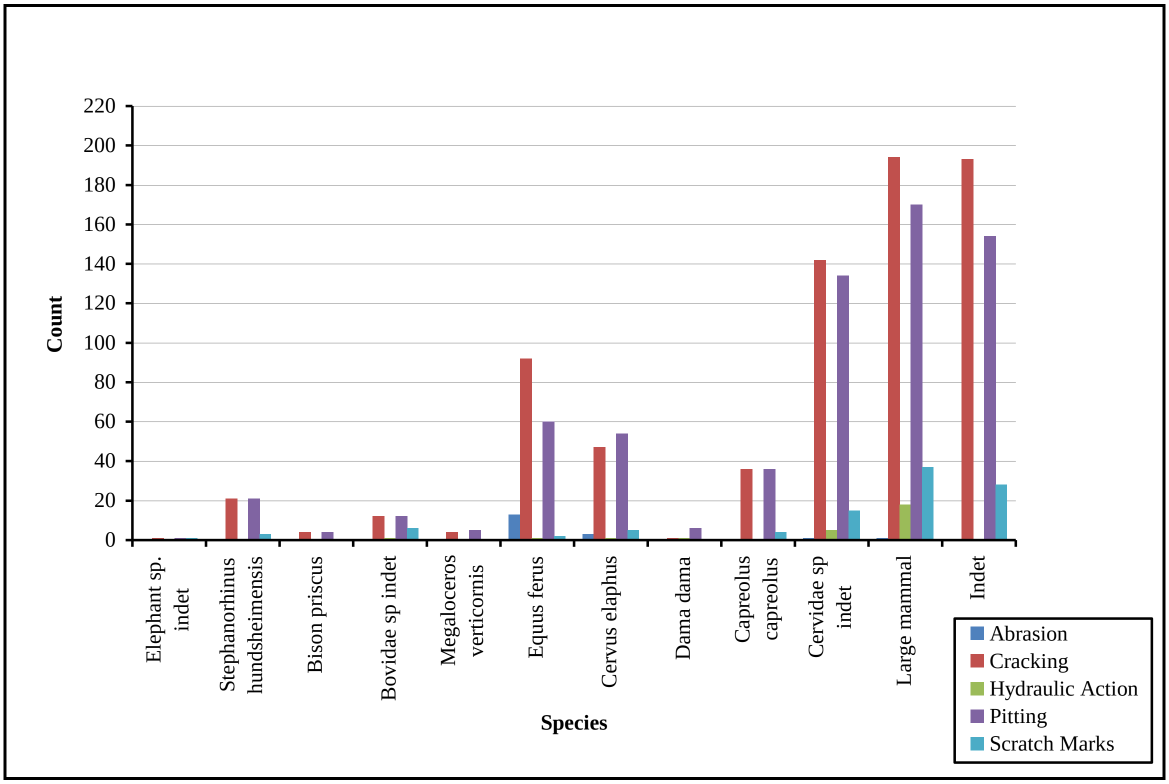

Figure 5.6 Distribution of different types of natural modification in Boxgrove assemblage

Figure 5.7 Indeterminate long bone fragment highlighting hydraulic rounding around fracture edge Specimen BOX F5856 from Unit 4u, probably derived from intertidal deposits of Unit 4a/4b by fluvial reworking

5.3.1 The Channel Deposits

Higher rates of river flow/energy frequently cause the preferential alignment of bone fragments' long axes to the direction of channel flow (see Fernadez-Jalvo and Andrews, 2003 for more detail). Major long-axis orientation of faunal specimens from the Boxgrove channel deposits is NE to SW with other minor directions of alignment. The major long-axis orientation of faunal material is not in the recorded direction of channel flow, which is NNW to SE (see Figure 5.8). Long bones are particularly good indicators of river channel spatial orientation, often affording less resistance to channel transport compared with larger elements such as the scapula, pelvis and cranium (Fernadez-Jalvo and Andrews, 2003; Stopp, 1997; Voorhies, 1969). The long-axis orientation of long bones in the channel deposits again highlights limited evidence for alignment to channel flow (see Figure 5.9), and the configuration of faunal material perpendicular to the direction of flow could indicate a slow flow regime unable to orientate bones to the direction of flow.

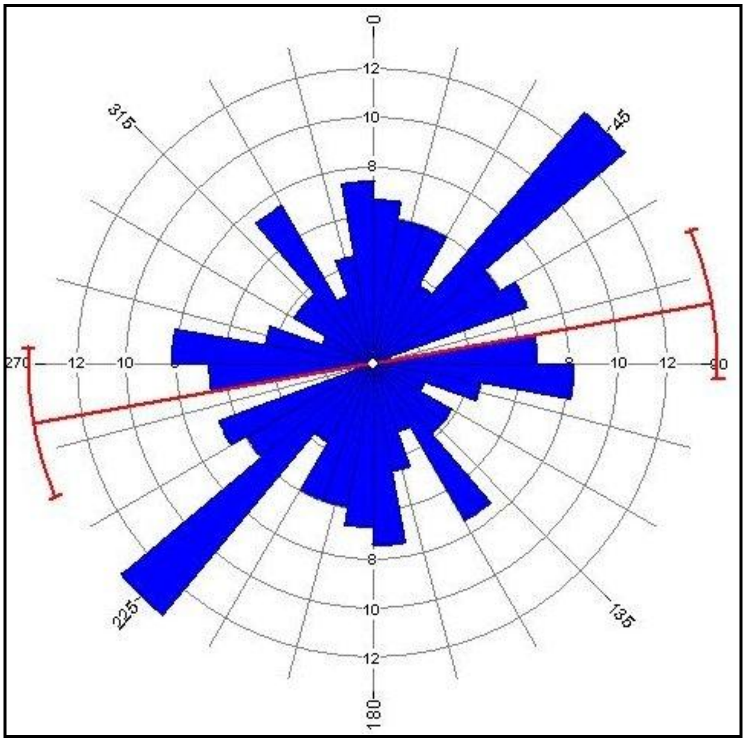

Figure 5.8 Faunal long-axis orientation for material from the Q1/B channel deposits

The orientation of faunal material perpendicular to channel flow (NE-SW) suggests that material could have been deposited in the channel through hominin activity during periods of non-flow and through natural slumping during periods of stream flow. To a lesser extent some material could have become incorporated by the trampling action of other large mammals (see Chapter 6-8). The most likely explanation, however, is that the re-organisation of faunal long axes occurred during the processes of natural slumping of non competent sediments, on or around the river edge. The absence of significant hydraulic modification suggests that the channel had limited impact on the preservation and/or modification of material in these deposits.

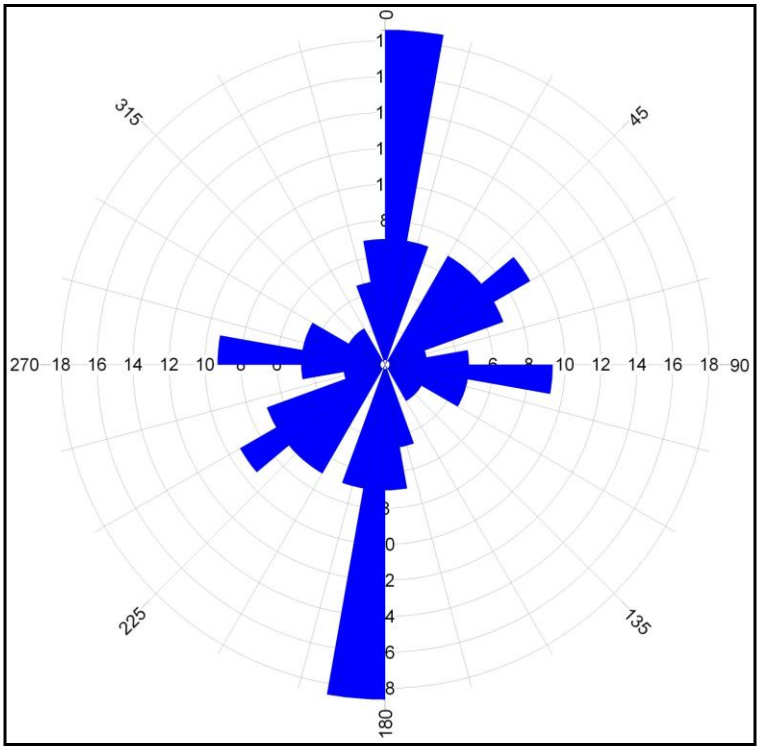

Figure 5.9 Long-axis orientation of long bone fragments from Q1/B channel deposits

5.4 Cervids

Numerous cervid species have been identified within the Boxgrove faunal assemblage from the extinct giant deer (*Megaloceros verticornis*) to species which are more recognisable across much of modern Britain and northern Europe (red, fallow, and roe deer) (see Parfitt, 1999a). At Boxgrove roe and red deer were the most identifiable cervid species although a large number of specimens had to be recorded as *cervidae* sp. *indet* (see Figure 5.10 and Appendix 2 Table 8). Although red and roe deer contain the largest number of identifiable specimens, a preliminary study of the NISP figures highlights the fact that well over half of the roe deer remains are composed of teeth (NISP= 75; 62%), compared with red deer material which includes a broader range of cranial and postcranial elements. Additionally, metrical data suggests that many of the bone specimens assigned to the indeterminate category are larger, relative to the roe deer remains, and therefore suggest possibly further fragmented red deer remains (Parfitt *pers comm.*); these will be considered alongside identifiable red deer remains in the following analysis.

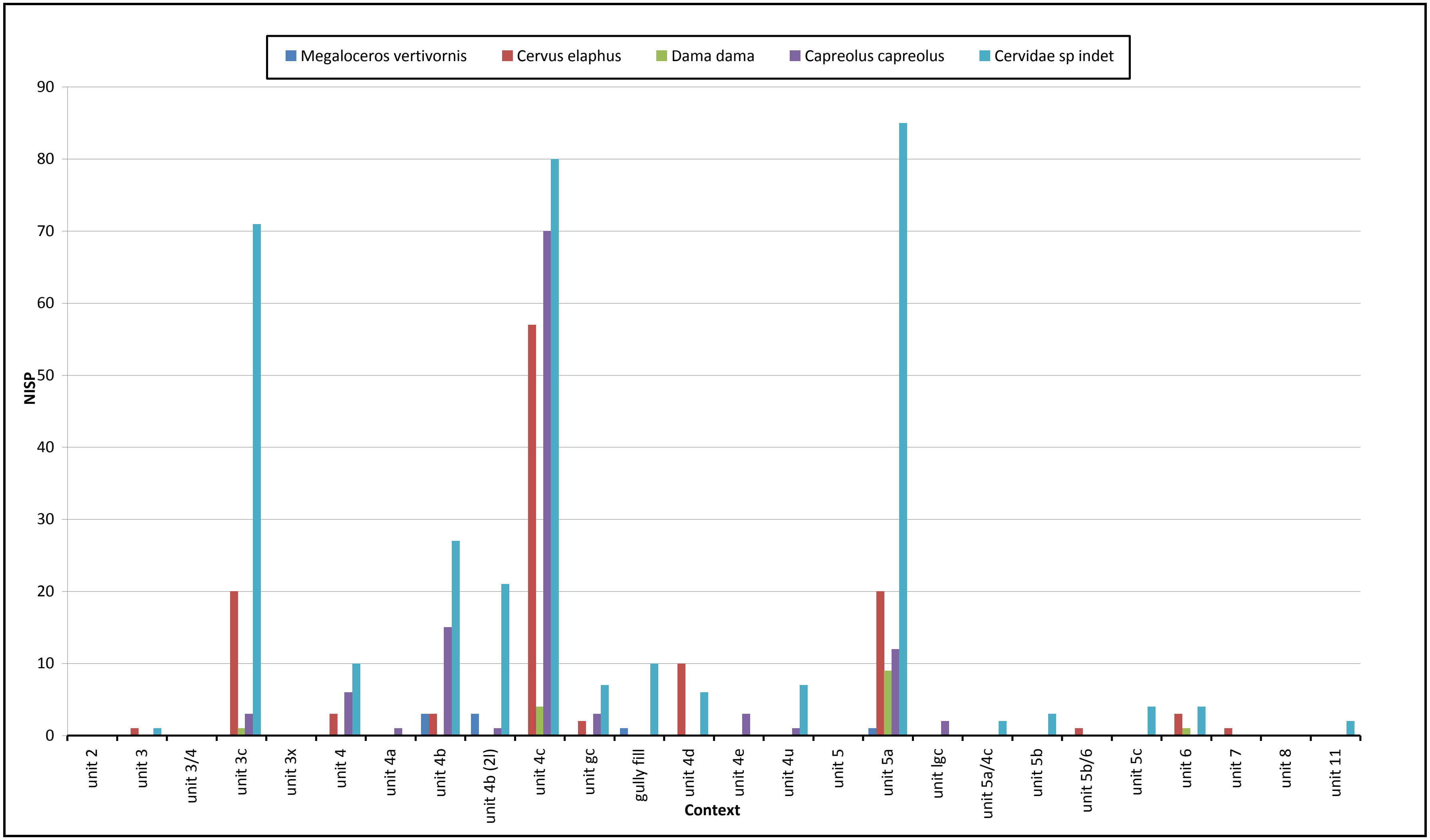

Figure 5.10 Distribution of major deer species throughout the major contexts at Boxgrove

5.4.1 Red deer

The red deer (*Cervus elaphus*) represents the most commonly identified deer species from Boxgrove (NISP= 121; 14.6%) with a dominance of postcranial (67.8%) over cranial elements (24%) (see Appendix 2 Table 9; Figure 5.11 and Figure 5.12). Those specimens assigned to red deer equate to a small minimum number of elements (MNE) when using skeletal elements (MNE= 4 based on scapula), although this number increases when using cheek teeth (MNE= 10 based on molars). In turn, this small MNE value relates to a similarly small minimum number of individuals (MNI) when element pairing and fusion data are considered (MNI= 2 based on scapula). The MNI rises again when using the dental pairing of molar teeth (MNI= 5 based on molars). The MNI obtained using dental pairing would suggest a large number of individuals, though this figure is not supported by an analysis of the MNI from the postcranial skeleton. The postcranial MNI/MNE values are smaller compared to those produced using dental material. This variation in MNI counts is a result of increased fragmentation of the post-cranial skeleton through the destruction/removal of elements by various taphonomic processes (see below).

Although the assemblage is fragmented the ability to refit specimens has allowed for more accurate quantification. The absence of significant weathering or other natural modification is suggestive of a relatively *in-situ* faunal deposit and strongly suggests that a combination of predator-scavenger and hominin action is responsible for the Boxgrove faunal accumulation. An initial assessment of the red deer assemblage appears to highlight a relatively *in situ* deposit though it is vital to determine, before progressing further into a more detailed analysis of bone surface modification, whether the faunal deposit has undergone any element destruction related to the relative mineral density of skeletal elements.

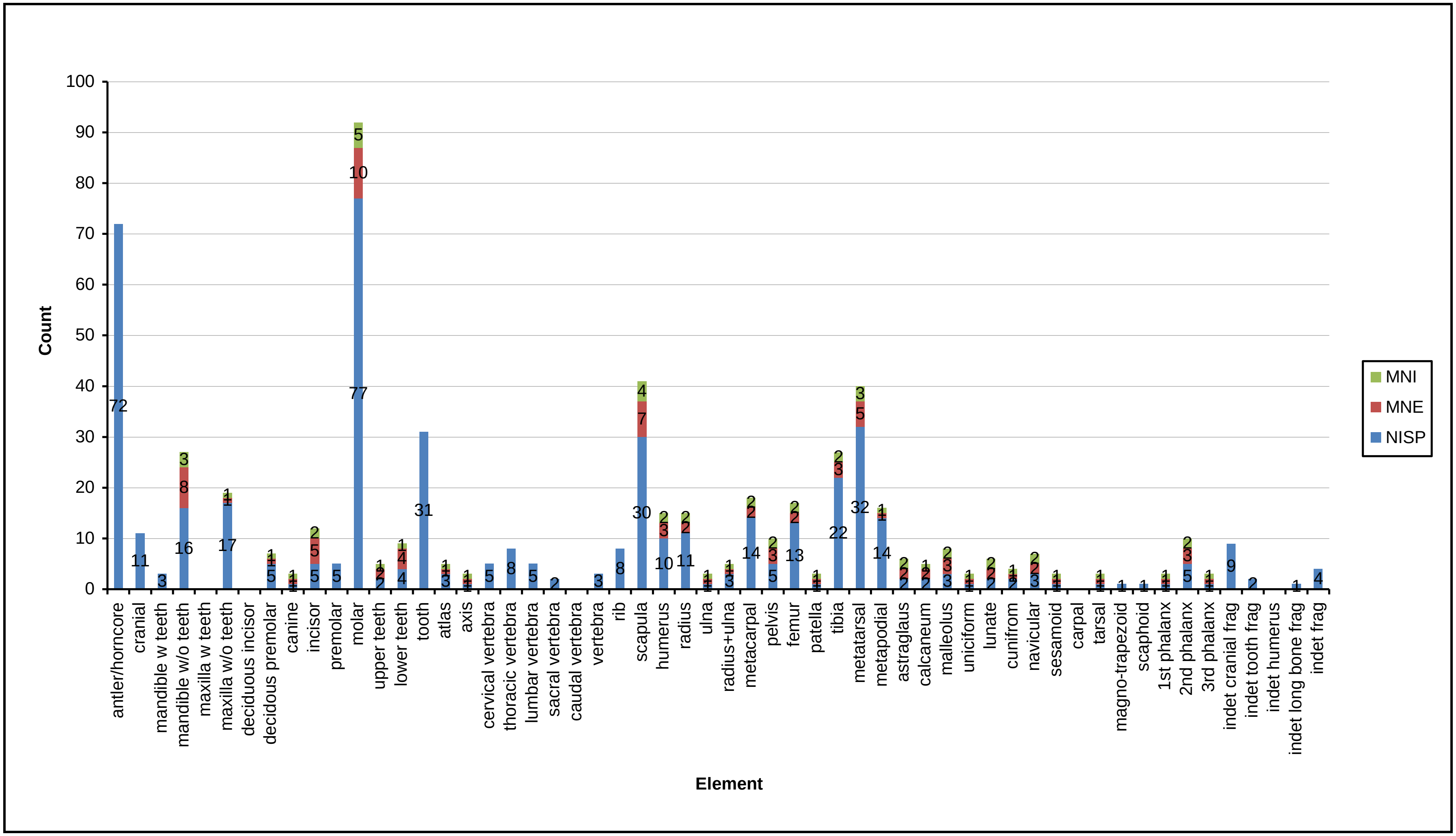

Figure 5.11 Combined red deer and cervid sp. indet NISP, MNE and MNI counts

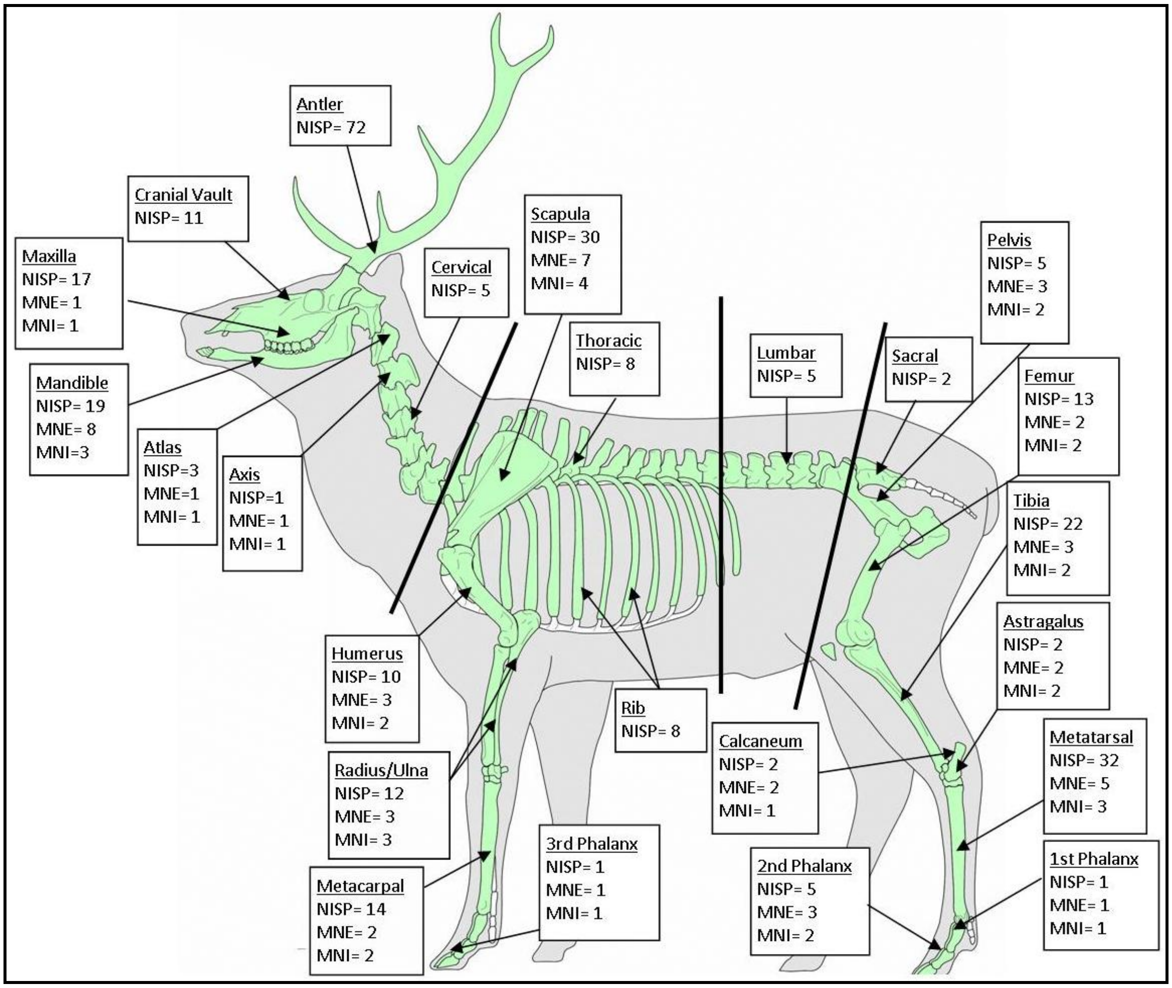

Figure 5.12 Red deer skeletal representation with NISP, MNE and MNI values
For dental values see Figure 5.11 and Appendix 2 Table 9; skeletal outline modified from Yvinec *et al* (2007)

It is important to establish whether the faunal assemblage highlights any patterns of survival related to relative mineral density (see particularly Kreutzer, 1992; Lam *et al.*, 1999; Lam *et al.*, 2003; Lyman, 1994; Stopp, 1997). Cranial fragments are preserved rarely and are normally represented either by mandibular (NISP= 15) or maxilla fragments (NISP= 17). Closer examination of the preserved portions (see Appendix 2 Table 10) show that the specimens represent the denser portions (diastema and tooth row) as highlighted by Lyman (1994). The high representation of red deer dentition (NISP=130; 27%) at Boxgrove almost certainly pertains to the survivability of these elements. Antlers, which are similarly dense, are also well represented at Boxgrove (NISP= 72; 14.9%), as on most other Palaeolithic sites (see Lynford, Swanscombe case studies). The fragmentary nature of the excavated antlers possibly reflects the removal and use of these elements as percussors by hominin populations: this phenomenon will be discussed in more detail in the sections below (see Wenban-Smith, 1999 for more detail).

Red deer postcranial remains are common and include elements from both the axial and appendicular regions. The entire vertebral column is represented by elements from each major anatomical region (see Appendix 2 Table 11). Although the transverse and spinous processes are the weakest portion of the vertebral column, there are similar numbers of these specimens represented compared with the denser vertebral centrum.

The scapula is highly fragmented (NISP= 30; MNE= 7) and corresponds to a small number of individuals (MNI= 4) (see Appendix 2 Table 12). Both the dense and less dense scapula portions are well represented and preserved. The ability to refit specimens suggests good preservation, rapid burial and limited pre or post burial transport of bone fragments: thus, confirming the weathering data. Conversely, the pelvic girdle is poorly represented in comparison to the scapula. Of the pelvic bones the acetabulum is the densest portion and better represented (NISP= 5) but the sample size is too small to make further inferences (see Appendix 2 Table 13). Interestingly, the pelvic girdle appears to be conspicuously absent from other species, both identifiable and indeterminate, which is probably the result of hominin activity (see Section 5.10.1).

The fore and hind limbs appear to illustrate a similar pattern to that illustrated by other elements; both are represented by a small number of specimens (humerus NISP= 10; radius+ulna NISP= 11; femur NISP= 13; tibia NISP= 22) (see Appendix 2 Table 14). The ability to refit these specimens, combined with fusion and aging data corresponds to a small MNE and MNI value for both (n= 2). This small figure appears to suggest some fragmentation of these elements. The lower portions of the appendicular skeleton (metapodials, carpals/tarsals, phalanges) are very well represented (see Figure 5.11) though this is not necessarily surprising as these have been highlighted as the most robust skeletal portions (Lyman, 1994). Although the carpals/tarsals and, to some degree, the phalanges are complete, the metapodials illustrate considerable fragmentation which is similar to the upper appendicular skeleton (see Appendix 2 Tables 15 & 16). Although each element is represented by a large NISP (metacarpal= 14; metatarsal= 32; metapodial= 14), these represent very few elements (metacarpal MNE= 2; metatarsal MNE= 5; metapodial MNE= 1) and a correspondingly small MNI (metacarpal MNI= 1; metatarsal MNI= 2; metapodial MNI= 1).

Both the upper and lower portions of the appendicular skeleton appear to indicate significant fragmentation and it is necessary to assess whether such bone breakage relates to the differential destruction of specific portions (see Appendix 2 Table 14). As highlighted previously specific portions of longbones have different relative densities (see Chapter 3), with the diaphyses being the densest portion of the element. Using the criteria provided by Stopp there is a corresponding dominance of shaft portions compared to epiphyses (Stopp, 1997 and Chapter 3). When comparing epiphyseal representation the distal epiphyses show greater representation than the proximal though this could not be referred to as dominance. Similarly, the proximal radius illustrates a slightly larger representation than the distal epiphysis, as suggested by Stopp (1997). The representation of longbone portions highlights a limited pattern of differential preservation though the densest portions are in no respect dominant. Indeed, the similar representation of most portions appears to suggest that preservation is not related to the differential density of these elements and indicates that other agent(s), particularly hominins, were responsible for the observed fragmentation.

The red deer skeletal profile highlights significant fragmentation with a large number of specimens relating to a limited number of elements and hence individuals. The skeletal part representation does not highlight any diagnostic pattern that could be assigned to a specific agent; such as the density mediated destruction of specific element portions, removal of epiphyses through carnivore gnawing or the transport of long bones off site by hominins.

Predator-scavenger modification

There is evidence for predator-scavenger modification on red deer remains (2.3% of total NISP) although this was restricted to postcranial elements (see Appendix 2 Table 17; Figure 5.13). Most of the modification comprises tooth scratches on elements (axis, scapula blade, tibia), probably from the removal of small scraps of meat in these regions (Figure 5.13). The presence of tooth pits (femur, calcaneum) and crenelation (rib head, metatarsal) suggests more prolonged tooth contact with these elements and perhaps reflects there disarticulation of these elements. For example, the crenelation of the rib head suggests the disarticulation of this element from the vertebral column, perhaps indicating the continued availability of small amounts of meat (see Figure 5.14). The gnawing of the metatarsal shaft was a deliberate attempt to access marrow; however, the absence of significant predator-scavenger modification on other elements, particularly long bones, suggests a small or limited amount of meat remained on the carcasses. The absence of nutrient opportunities can be explained by the large quantity and varied distribution of hominin modification.

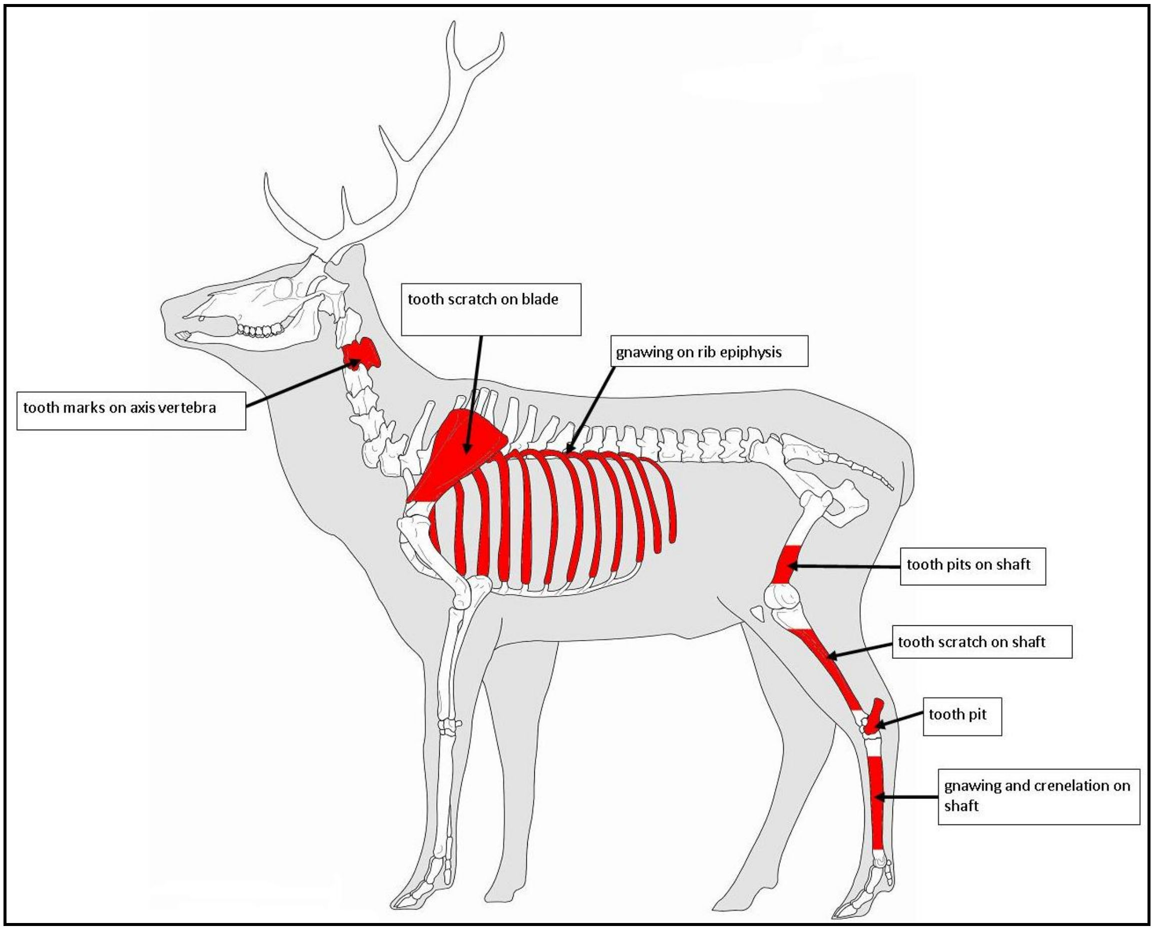

Figure 5.13 Distribution of predator-scavenger modification across red deer skeleton
Skeletal outline modified from Yvinec *et al.* (2007)

Figure 5.14 Evidence for predator-scavenger crenelation on rib head (BOX F139)

Figure 5.15 Predator-scavenger tooth scratch on scapula blade (BOX F6929)

Hominin modification

The red deer remains illustrate significant modification across the entire skeleton on both cranial and postcranial specimens (20.3% of total NISP) (see Figure 5.16; Appendix 2 Table 18). The presence of cut marks on an antler base suggests the deliberate removal of the antler from the skull, perhaps to use as a soft hammer for lithic manufacture (Wenban-Smith, 1999). Cut marks on the cranial fragments relate to skinning, and demonstrate that hominins had primary access to red deer carcasses (see Figure 5.17). Cut marks on teeth roots might reflect the disarticulation of the mandible from the cranium, with subsequent muscle removal, and accidental damage caused during removal of the tongue (see Figure 5.18).

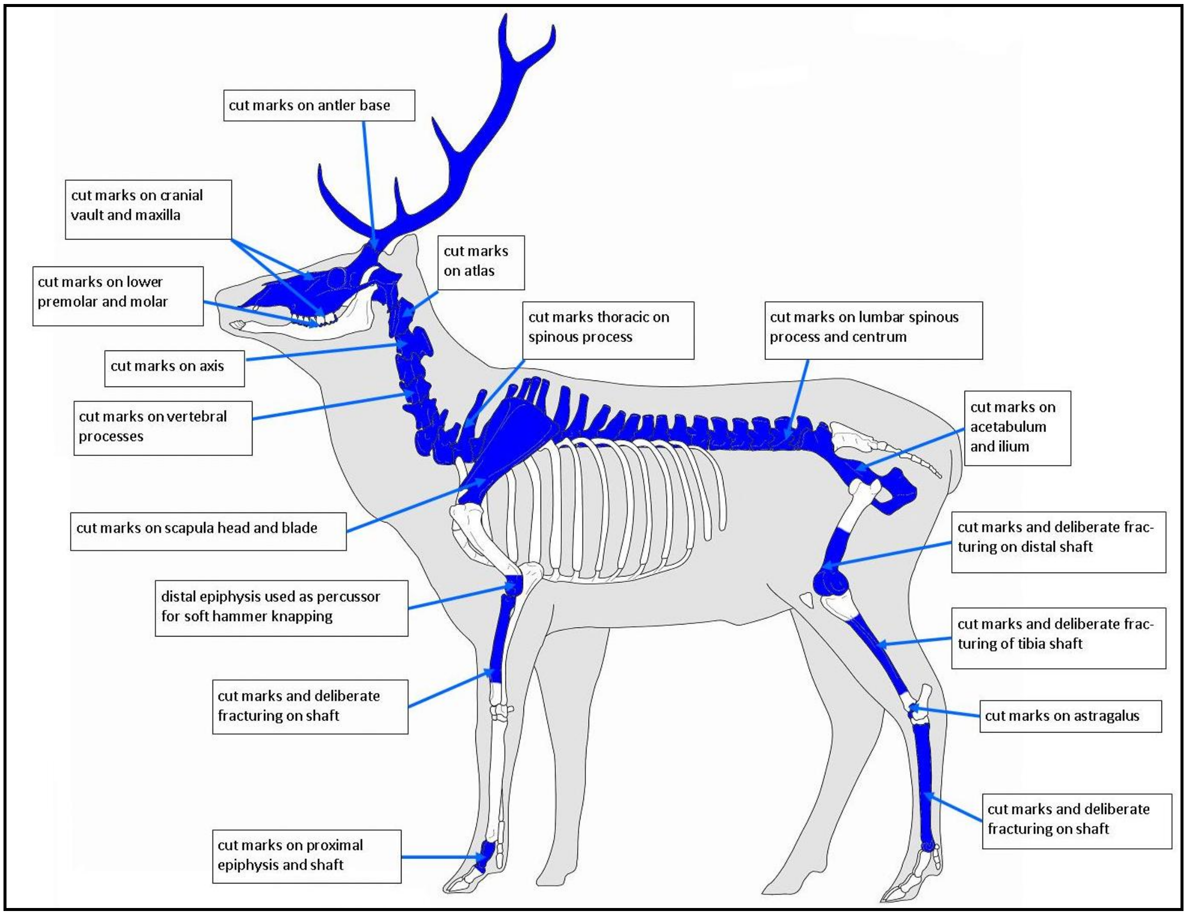

Figure 5.16 Distribution of hominin modification across red deer skeleton
Skeletal outline modified from Yvinec (2007)

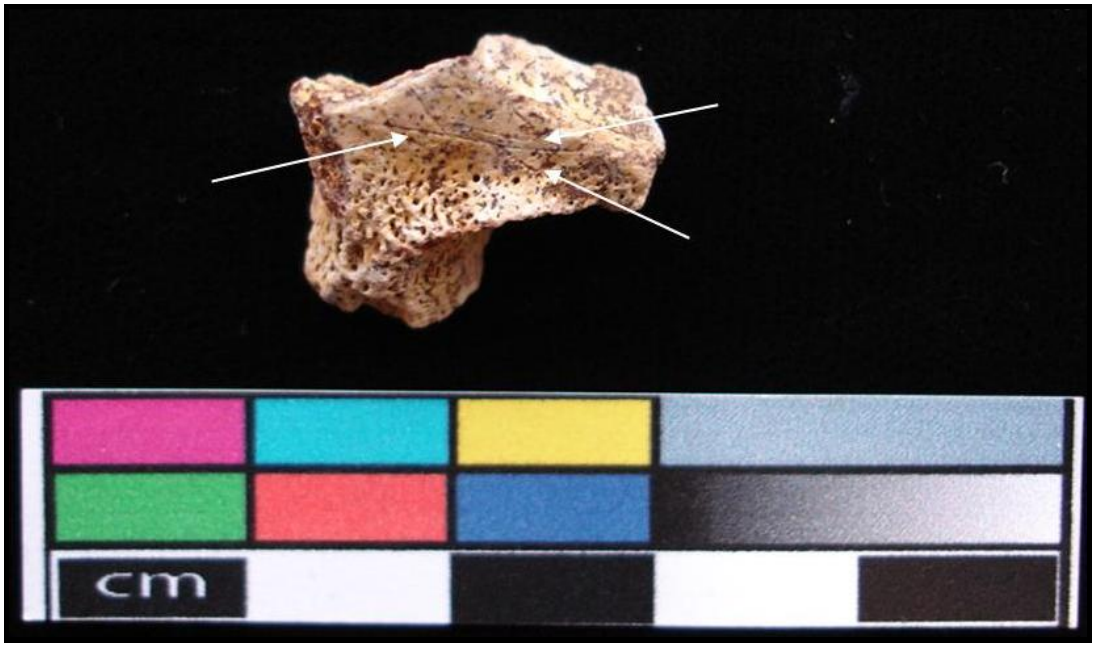

Figure 5.17 Cut marks on maxilla fragment (BOX F69)

Figure 5.18 Cut mark on red deer lower molar (BOX F4000)

Hominin modification has been recorded across the entire vertebral column. The particularly heavily cut marked atlas (one specimen preserves 16 individual cut marks) shows that the head was detached from the rest of the carcass. If hominins were not exploiting the brain as a nutritional resource it would make more sense to remove the head prior to skinning of the carcass. However, the evidence from the red deer fauna strongly indicates that the brain was of nutritional importance to these hominin communities. In addition, the large quantity of cut marks on other cervical vertebrae would suggest the removal of meat from this region (see Figure 5.19). A similar pattern was observed on the remainder of the vertebral column and is suggestive of butchery and meat removal from the thoracic and lumbar regions.

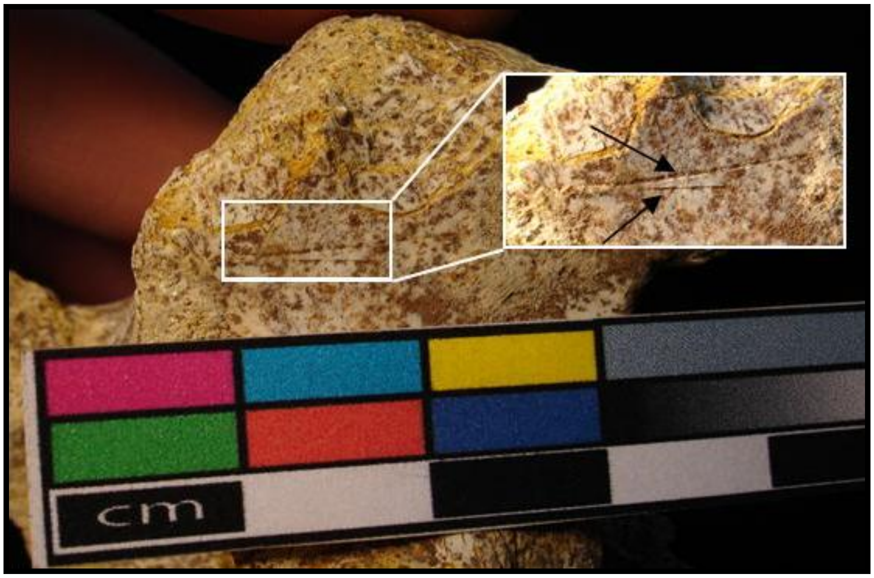

Figure 5.19 Cut marks on thoracic vertebra process (BOX 7497)

The scapula region illustrates evidence for sustained hominin butchery and modification and also the presence of predator-scavenger modification. Although cut marks are recorded across the entire element, the scapula head is less cut marked (see Figure 5.20) perhaps suggesting that the scapula and fore limb were not disarticulated during butchery. Certainly, the high intensity of modification on this region suggests primary access to the meat on the shoulder.

Figure 5.20 Cut marks on posterior of scapula blade (BOX F7243)

There is no direct evidence for hominin modification or meat removal on the humerus, although the distal epiphysis of one element has been utilised as a percussor for lithic tool manufacture (see Figure 5.21). It is possible that this may reflect the *in situ* manufacture or re-working of lithic tools at this location, which can be observed at other locales (see equid at GTP 17) (Pope and Roberts, 2005; Roberts, 1999a, 1999b). The radius demonstrates evidence for the removal of meat from this element though the major hominin modification relates to the deliberate fracturing of this bone to extract the nutrient rich marrow. The combination of these two modifications, along with evidence from other elements suggests that these populations had primary access to the meat from the red deer carcasses.

Figure 5.21 Distal red deer humerus used as a percussor
Note surface damage

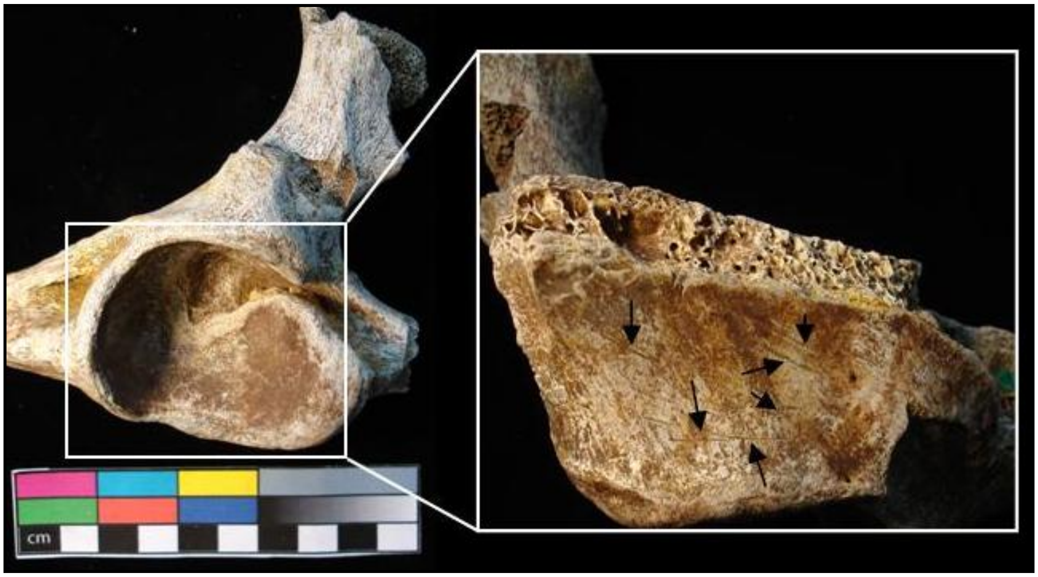

Figure 5.22 Cut marks around pelvic acetabulum (BOX F7416)

The hind limb demonstrates a similar pattern of primary access to carcass nutrients as the forelimb with evidence for skinning/defleshing and fracturing. The pelvis demonstrates evidence for cut marks around the acetabulum which suggests the disarticulation of the femur from the pelvic girdle (see Figure 5.22) and the presence of cut marks on the ilium and ischium indicates the removal of small portions of rump meat. Both femur and tibia display similar modification, with the removal of meat and the deliberate fracturing of these longbones to access the marrow (see Figure 5.23). The pattern for the metapodials is similar to that for the upper limbs. The presence of cut marks on tarsals and phalanges suggests the disarticulation and removal of the feet and ankle region from the rest of the carcass and is further evidence to suggest that hominins had access to articulated carcasses and nutrients, again suggestive of primary access.

The absence of significant weathering and other natural modification indicates a rapidly buried faunal assemblage and the large quantity of both predator-scavenger and hominin modification suggests that these agents had a more important role in the accumulation and modification of the red deer faunal assemblage. The varied type, quantity and distribution of hominin modification, compared to predator-scavenger modifications, demonstrates that hominins had primary access to red deer carcasses, which were holistically exploited for meat, marrow and secondary products such as brain and tongue.

Figure 5.23 Refitting femur shaft fragment (BOX F1) with impact point from marrow-processing

5.4.2 Fallow deer

Fallow deer are represented by very few specimens (NISP= 15) accounting for a very small percentage of the faunal assemblage (1.8%). These specimens represent a small number of elements and individuals based both on dental pairing (MNE= 5; MNI= 1) and traditional skeletal techniques (MNE=2; MNI= 1, based on the magnum) (see Figure 5.24 and Appendix 2 Table 19). The presence of large quantities of teeth (NISP= 10) together with dense metapodial portions (distal epiphysis NISP= 1) and tarsal bones perhaps reflect their greater relative bone density. However, the preservation of a refitting scapula (NISP=1; MNI=1) suggests that the less dense elements of fallow deer were also preserved on site. The absence of other skeletal elements might therefore be the result of hominin modification in light of an absence of carnivore modification. However, the size of the assemblage might predicate any clear determinations about the relative importance of both natural and hominin agents.

Predator-scavenger modification

No predator-scavenger modification was identified or recorded on fallow deer remains though this could be related either to the small assemblage size, possible transport of elements off site by hominin and predator populations or a combination of all three factors.

Hominin modification

The only evidence for hominin modification on fallow deer remains were cut marks identified on the scapula (see Figure 5.25). The location of the cut marks around the scapula head suggests disarticulation of this element from the remainder of the carcass possibly for transport or ease of processing. The distribution of cut marks across the scapula blade indicates meat processing and implies that hominins had primary access to the meat available on this carcass. The evidence for disarticulation and meat processing could perhaps be used to explain the absence of other fallow deer remains, although this relies heavily on negative evidence. However, the absence of any carnivore modification certainly suggests hominin primacy at the carcass site, element disarticulation and possible off site transport.

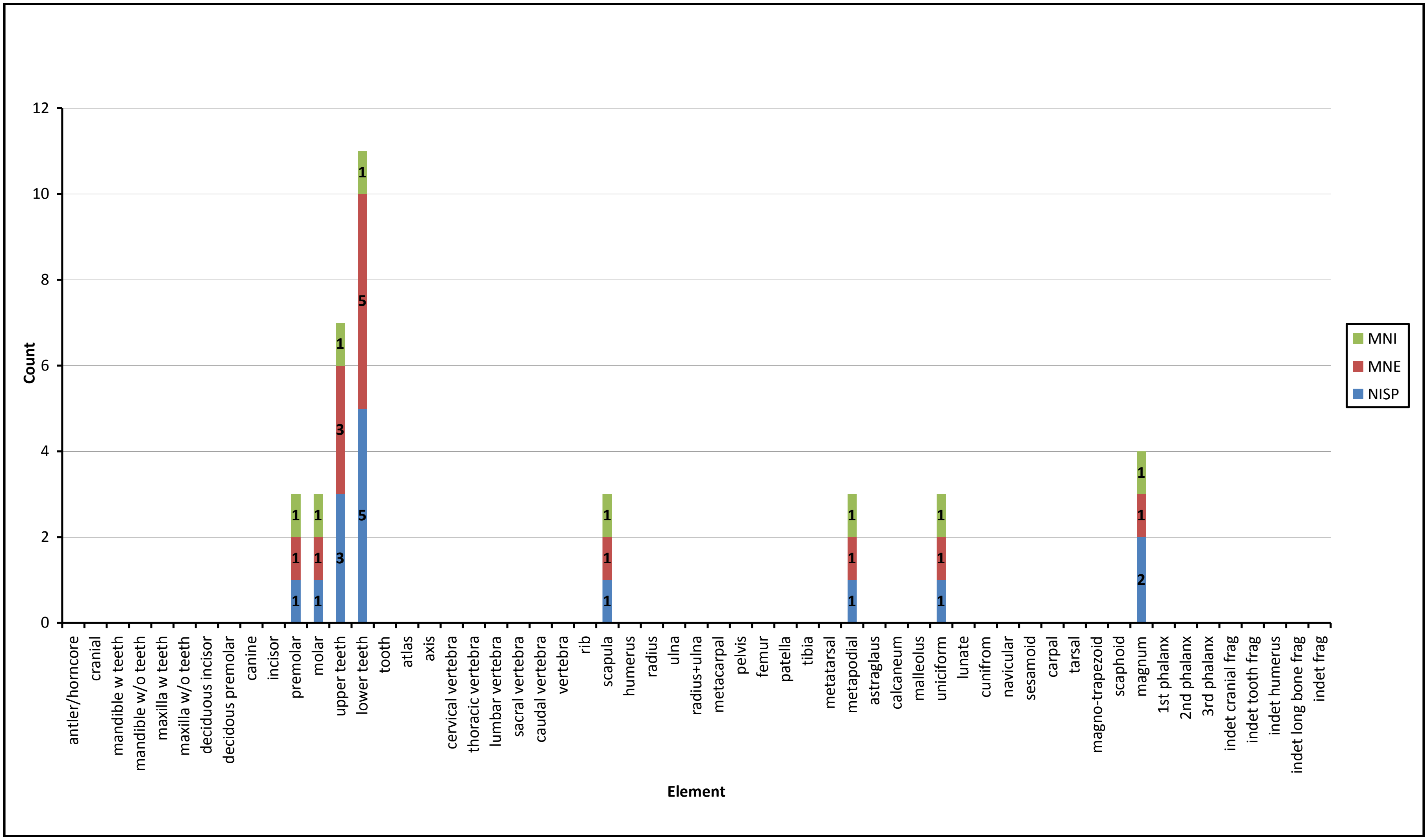

Figure 5.24 Fallow deer NISP, MNE and MNI counts

Figure 5.25 Cut marks on fallow deer scapula

5.4.3 Roe deer

The roe deer is fairly well represented at Boxgrove (NISP= 121) representing 14.6% of the total excavated faunal assemblage (see Figure 5.26 and Appendix 2 Table 20).

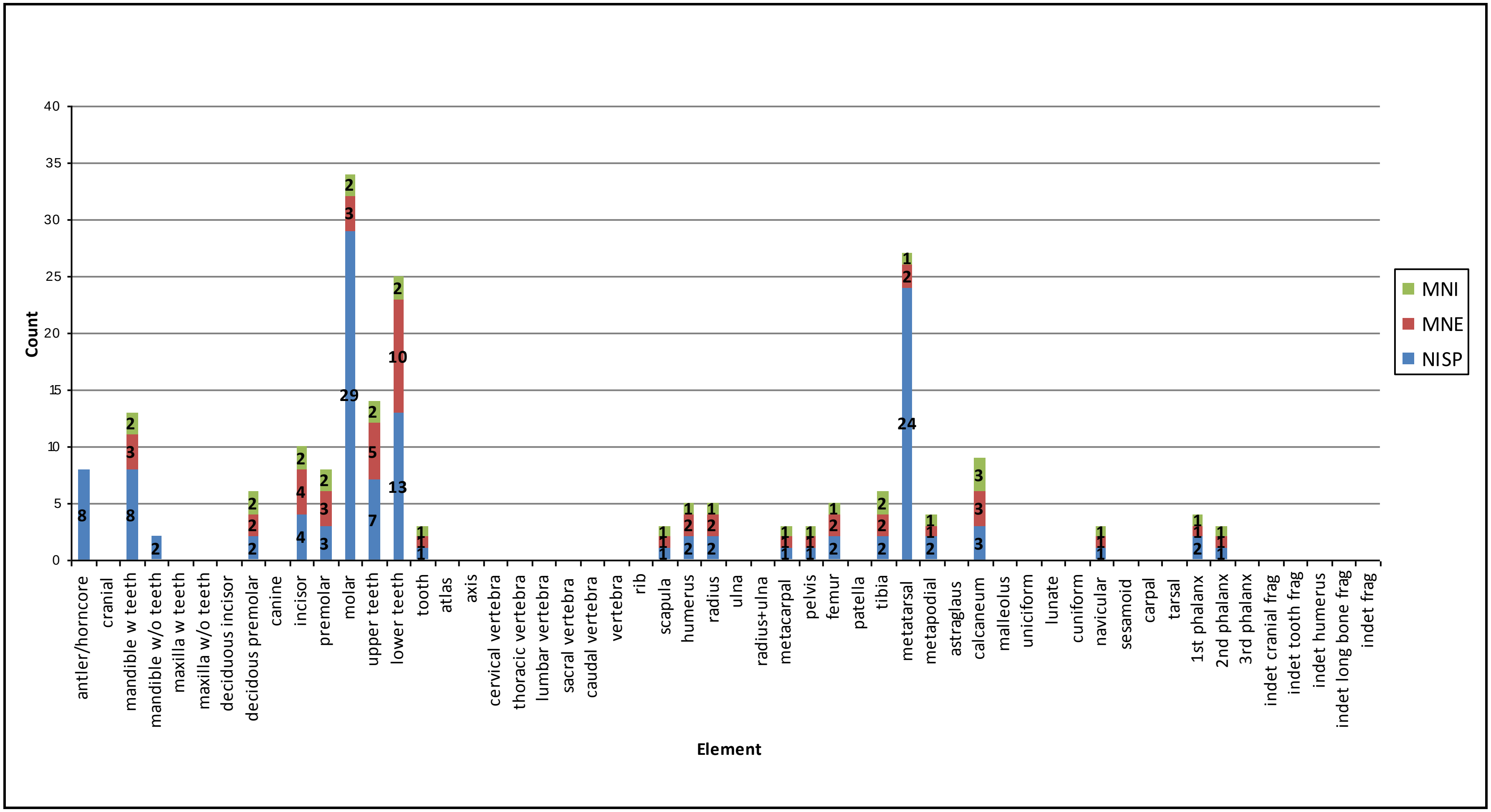

Figure 5.26 Roe deer NISP, MNE and MNI counts

The skeletal profile illustrates a range of elements preserved although cranial portions are better represented than post-cranial elements again due to the large numbers of teeth (NISP= 60). As previously discussed, teeth always preserve well due to their high mineral density. In calcareous deposits the same is true of antler, though this element is less well represented for roe deer (NISP= 8), perhaps due to the smaller size of their antlers. Despite a large NISP for teeth fragments these represent a low MNE/ MNI value (e.g. molar NISP= 29; MNE= 3; MNI= 2) though this figure does not necessarily relate to element break up, but may indicate that teeth are easier to identify and refit than other body parts. Other cranial remains consist of mandibular fragments (NISP= 7) with the majority of surviving portions being from denser regions such as the tooth row (NISP= 8) (Lyman, 1994) (Appendix 2 Table 21). Again these illustrate some fragmentation and a correspondingly low MNE/MNI (MNE=3; MNI=2). There is a complete absence of identifiable roe deer vertebra. It is possible that some of these vertebral specimens are contained within specimens identified as indeterminate, although being of lower density they could have been destroyed by carnivore processing or off site transport.

In contrast to the red deer body part representation, postcranial remains of roe deer are particularly sparse with the exception of the metatarsal (see Appendix 2 Table 22). Both the fore and hind limbs are represented by a limited number of fragments which corresponds to a similarly low MNE/MNI figure (see Appendix 2 Table 20). Surviving portions of these long bone elements consist mainly of the dense shaft fragments although a few epiphyses are preserved (Appendix 2 Table 22). For roe deer, the smallest cervid species, a pattern of skeletal representation similar to that for the red and fallow deer has been observed; with dense bone portions such as the acetabulum and scapula head preserved along with the blade and ilium (see Appendix 2 Table 23 & 24).

The metapodials, carpals and phalanges are the largest group of elements to survive from the postcranial skeleton. The metatarsals demonstrate considerable fragmentation, with a limited number of elements and individuals represented (MNE= 2; MNI=1). The portion preservation highlights a dominance of dense shaft fragments (see Appendix 2 Table 22) although the proximal epiphysis is represented but by a smaller number of specimens. It is interesting that phalanges are only represented by proximal and distal epiphyses and the denser shaft fragments are absent, though these could have been destroyed by other natural attritional processes. The high density and survivability of these lower limb elements compared to other cranial and postcranial elements appears to suggest that some degree of fragmentation and selective removal of elements has occurred with roe deer skeletal remains. However, the small sample size of other post-cranial elements makes it difficult to make a more accurate assessment of density mediated destruction.

Predator-scavenger modification

The absence of any identifiable predator-scavenger modification would suggest that these faunal remains represent natural deaths.

Hominin modification

Hominin modification was only observed on one roe deer pelvis specimen (see Figure 5.27). Cut marks were located on the ilium, near to the acetabulum and possibly reflect the removal of remnants of meat from this region. The absence of any other hominin modification and selective destruction of less dense elements suggests that this isolated evidence for hominin modification reflects a more opportunistic subsistence approach, possibly the exploitation of resources from animals that had died naturally. This is in contrast to the more active primary access these hominin populations had to the nutrients from red deer carcasses.

Figure 5.27 Cut marks on roe deer pelvic acetabulum (anterior view)

5.4.4 Giant deer

The giant deer (*Megaloceros verticornis*) is only represented by upper dentition (premolar NISP= 2; molar NISP= 6) (see Appendix 2 Table 25). As has been discussed before, these elements are particularly dense and survive well on most sites. Absence of other skeletal elements makes comparison with other species impossible.

Hominin modification

The cut marks identified on the roots of 3 upper teeth could indicate disarticulation and muscle removal from the mandible as well as accidental impact during removal of the tongue (see Figure 5.28). The absence of other elements with identifiable signatures makes it difficult to form any firm conclusions about the importance of giant deer to the subsistence strategies of these hominin populations. It appears from the evidence available that access to these species was sporadic and the modification observed may reflect the exploitation of resources from an animal that had died naturally.

Figure 5.28 Cut marks on root of giant deer maxillary molar

5.5 Equid

Although skeletal remains of horse are found across the Boxgrove palaeolandsurface the major concentration was found in Quarry 2 GTP 17 (NISP= 132; 91%), this location therefore will be the major focus of this analysis, although equid material from other contexts will also be highlighted and discussed (see Figure 5.29). The equid remains at GTP 17 are concentrated within a restricted vertical horizon, which along with the presence of lithic and faunal refits and a lack of element duplication suggests that the material belongs to a single adult (Roberts, 1999b; Roberts and Parfitt, 1999b).

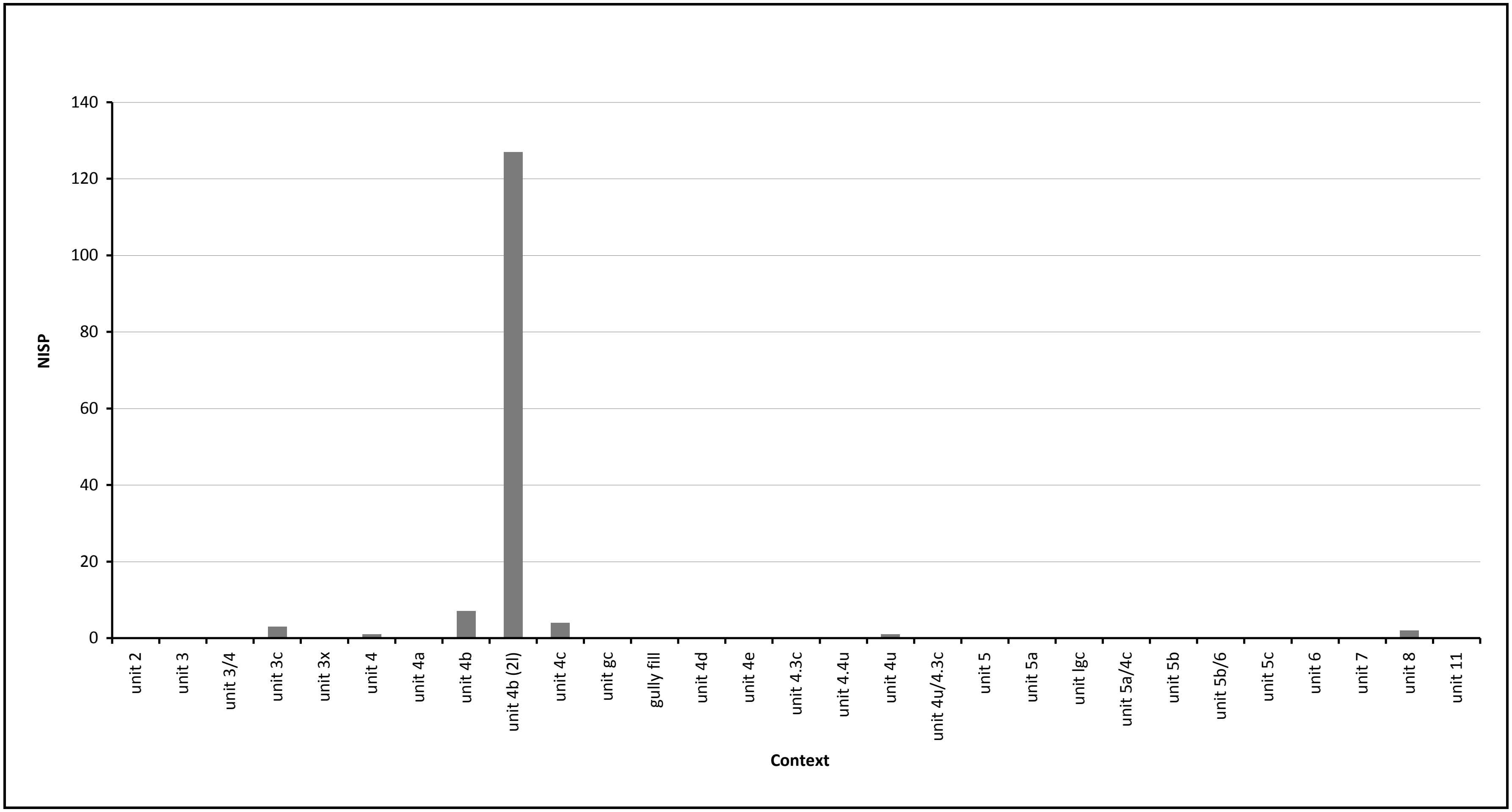

Figure 5.29 Distribution of horse remains throughout Boxgrove contexts

5.5.1 Horse

Skeletal representation from Quarry 2 GTP 17

Horse cranial remains excavated from GTP 17 are well represented (NISP= 70) (Figure 5.30 and Figure 5.31; Appendix 2 Table 26). The large quantity of mandibular specimens identified (NISP= 35) have been heavily fragmented, and correspond to a low MNE/MNI figure (MNE= 1; MNI= 1). Other non-dental cranial remains do not demonstrate a similar degree of fragmentation, and thus indicate a lower MNE and MNI value (stylohyoid and maxilla MNE=1; MNI= 1). Although cranial fragments illustrate evidence for heavy fragmentation, the sedimentary taphonomy and refitting of lithic and faunal material specimens from GTP 17 indicates that such destruction had occurred *in situ* (see below and section 5.10).

The equid skeletal profile is dominated by teeth (NISP= 24). Quantification produces a higher number of individuals than other cranial or postcranial elements (except atlas) (MNE= 11; MNI=3), though this is unsupported by the quantification of other post-cranial elements. The quantification pattern reflects the greater mineral density of equid dentition and more importantly the increased fragmentation of postcranial elements. Increased postcranial fragmentation correlates well with evidence from both predator-scavenger and hominin modification, and these processes provide a convincing explanation of skeletal fragmentation (see *hominin modification*).

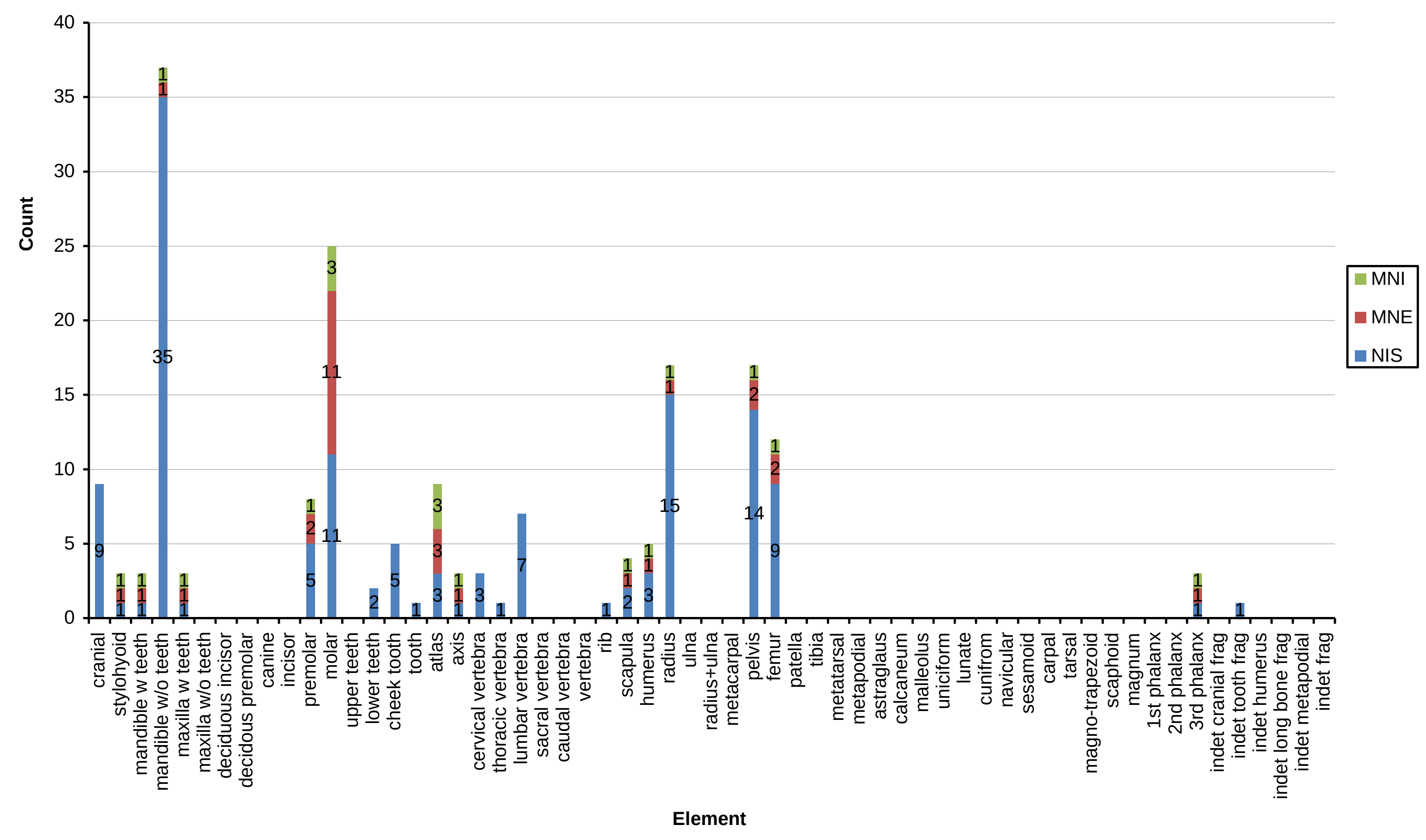

Figure 5.30 Horse NISP, MNE, and MNI counts

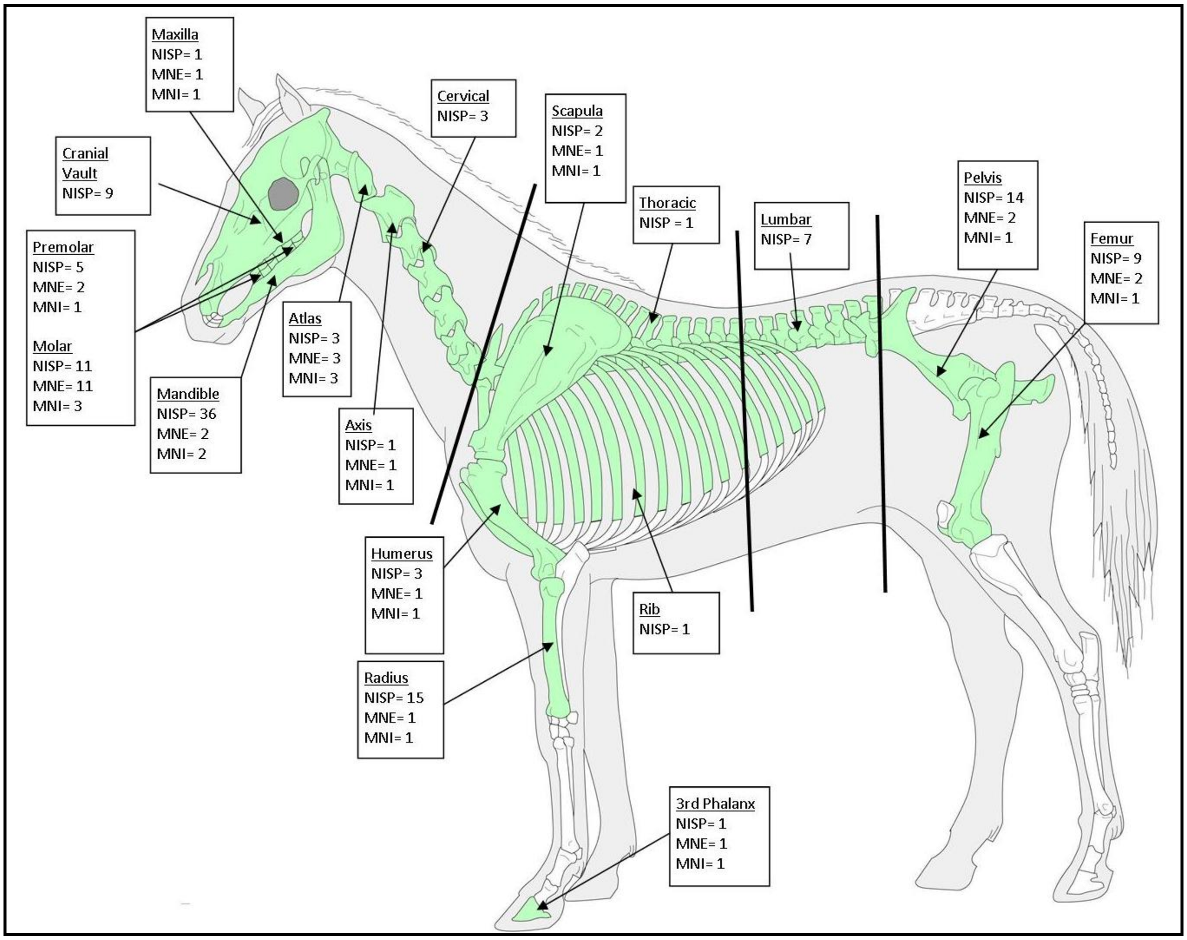

Figure 5.31 Horse skeletal representation with NISP, MNE and MNI values at GTP 17
Skeletal outline modified from Yvinec *et al* (2007)

Compared to other medium-sized species, particularly cervids, equid postcranial remains are limited and fragmentary (Figure 5.30 and Figure 5.31; Appendix 2 Table 26). All vertebral portions are represented including the dense centrum and less dense spinous processes (see Appendix 2 Table 27), and element survival does not appear to be correlated with the relatively low bone density of this region. The rib cage is represented by a single proximal epiphysis which makes further discussion about the relative density of this region impossible. However, bone weathering data indicates rapid burial, which in combination with the type and distribution of both predator-scavenger and hominin bone modification signatures suggests that these agents had an important role in assemblage accumulation.

Appendicular skeletal elements are varied in their representation. The scapula is identified by a small number of specimens, which indicate some fragmentation (see Appendix 2 Table

28), and relate to a small number of elements and individuals (MNE= 1; MNI= 1). A similar pattern was recorded for the humerus, which also has a low specimen count (NISP= 3), with bone portions restricted to the denser shaft fragments and distal epiphyses (see Appendix 2 Table 29). The radius is highly fragmented and represented by denser shaft fragments, which corresponds to a small numbers of elements and individuals (NISP= 15; MNE= 1; MNI= 1) (see Appendix 2 Table 29).

Element representation in the hind limb contrasts with the pattern identified in the fore limb. Both the pelvis and femur are represented by a large number of specimens (NISP= 14; NISP= 9) (see Figure 5.30; Appendix 2 Tables 29 & 30), although each element illustrate considerable fragmentation (MNE= 1; MNI= 1). The absence of metapodials, carpals/tarsals and phalanges demonstrates that relative bone density has not had an important role in faunal assemblage preservation (see Appendix 2 Table 29). The identification a single 3rd phalanx is in complete contrast to red deer, where a large number of often complete elements were identified.

Horse skeletal representation does not indicate the selective deletion or preservation of specific elements in relation to variations in relative bone density, as illustrated by an absence of denser ankle and foot bones and the presence of larger numbers of vertebrae. Most elements, with the exception of dental remains, indicate a single individual with evidence for the considerable fragmentation of some skeletal regions. The cranial and postcranial fragmentation does not represent the selective destruction of less dense skeletal elements by natural agents. Lithic knapping scatters and associated modification signatures suggest that the skeletal fragmentation is the result of both predator-scavenger and hominin behaviour (see below).

Predator-scavenger modification

Predator-scavenger modification was identified on equid remains though the quantity and distribution is limited compared to hominin modification (see Figure 5.32). The identification of a puncture wound on a cervical vertebra is evidence for sustained dental contact and could suggest disarticulation of the vertebral column (Figure 5.33). Carnivore gnawing, with crenelation, on long bone shafts is evidence of marrow extraction (see

Appendix 2 Table 31). The location gnawing on long bone shafts suggests a predator with greater masticator force, such as hyaena, which has been identified on site by coprolite material. Predator-scavenger modification recorded on the mandible and pelvis fragments suggest processing of these regions for meat. Predator-scavenger modification on the pelvic fragment overlies hominin modification, which indicates secondary access to this element by non-hominin carnivores (see Figure 5.34). The type and distribution of predator-scavenger modification suggests the secondary exploitation of horse carcasses for marrow and meat. The identification of *in-situ* flint knapping, extensive cut marked bone, overlain by predator-scavenger modification, and deliberately fractured skeletal remains suggests hominins had primary access to this horse carcass.

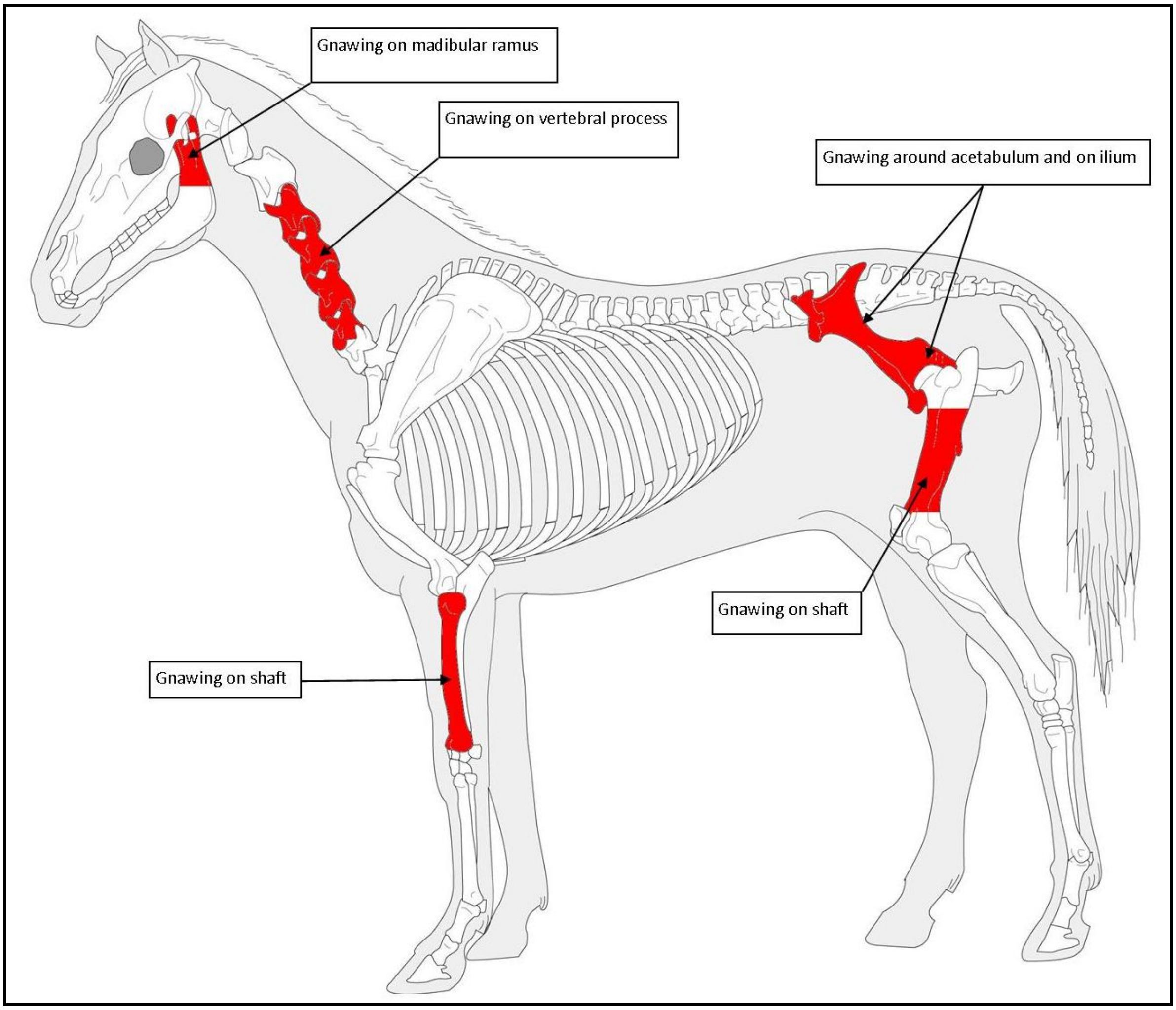

Figure 5.32 Distribution of predator-scavenger modification across equid skeleton
Skeletal outline modified from Yvinec *et al* (2007)

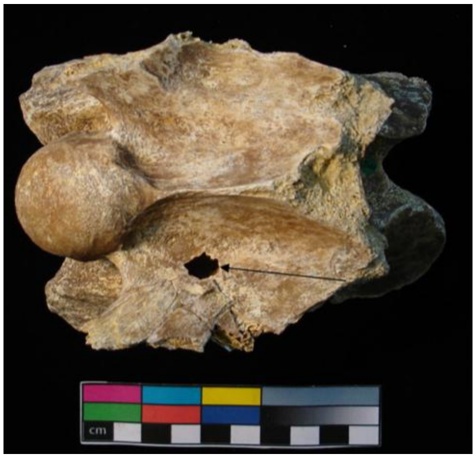

Figure 5.33 Predator-scavenger tooth puncture on equid cervical vertebra (BOX F5653)

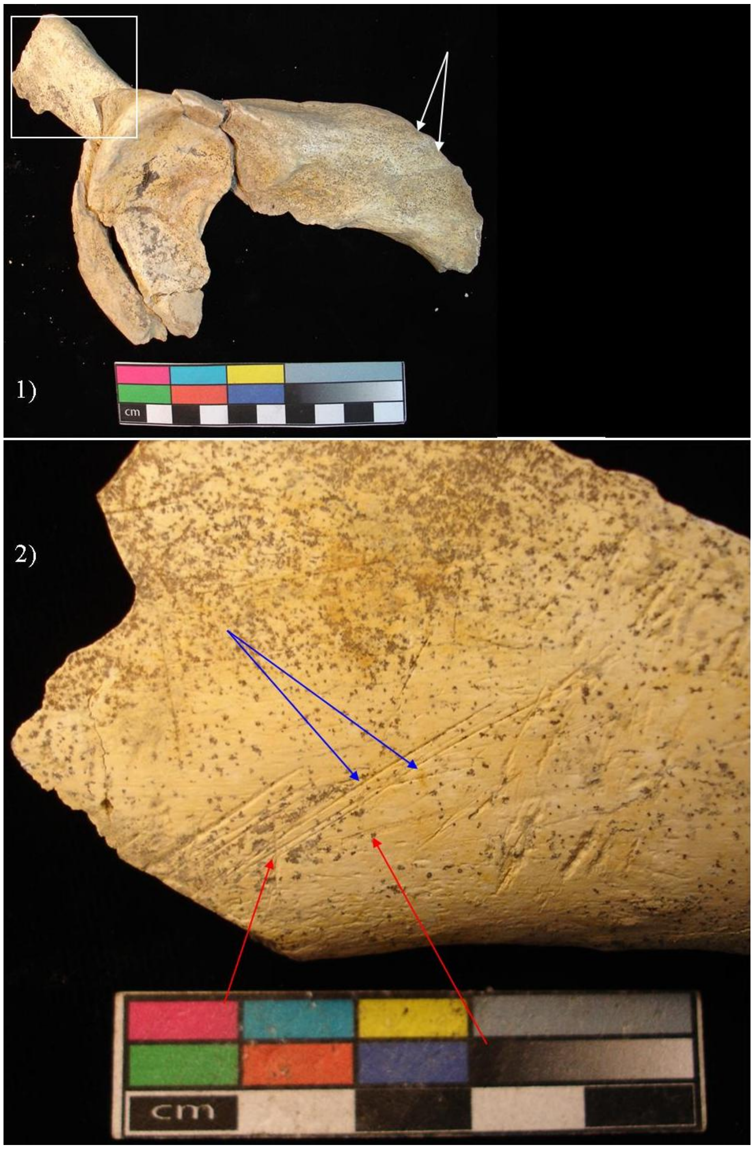

Figure 5.34 Predator-scavenger modification on horse pelvis from GTP 17 (BOX F362)
Showing 1) crenelation on ilium and 2) overlapping predator-scavenger tooth marks (red arrows) and hominin cut marks (blue arrows)

Hominin modification

The equid individual at GTP 17 appears to have been a relatively complete carcass as demonstrated by hominin modification distributed across both cranial and post-cranial elements (Figure 5.35 and Appendix 2 Table 32).

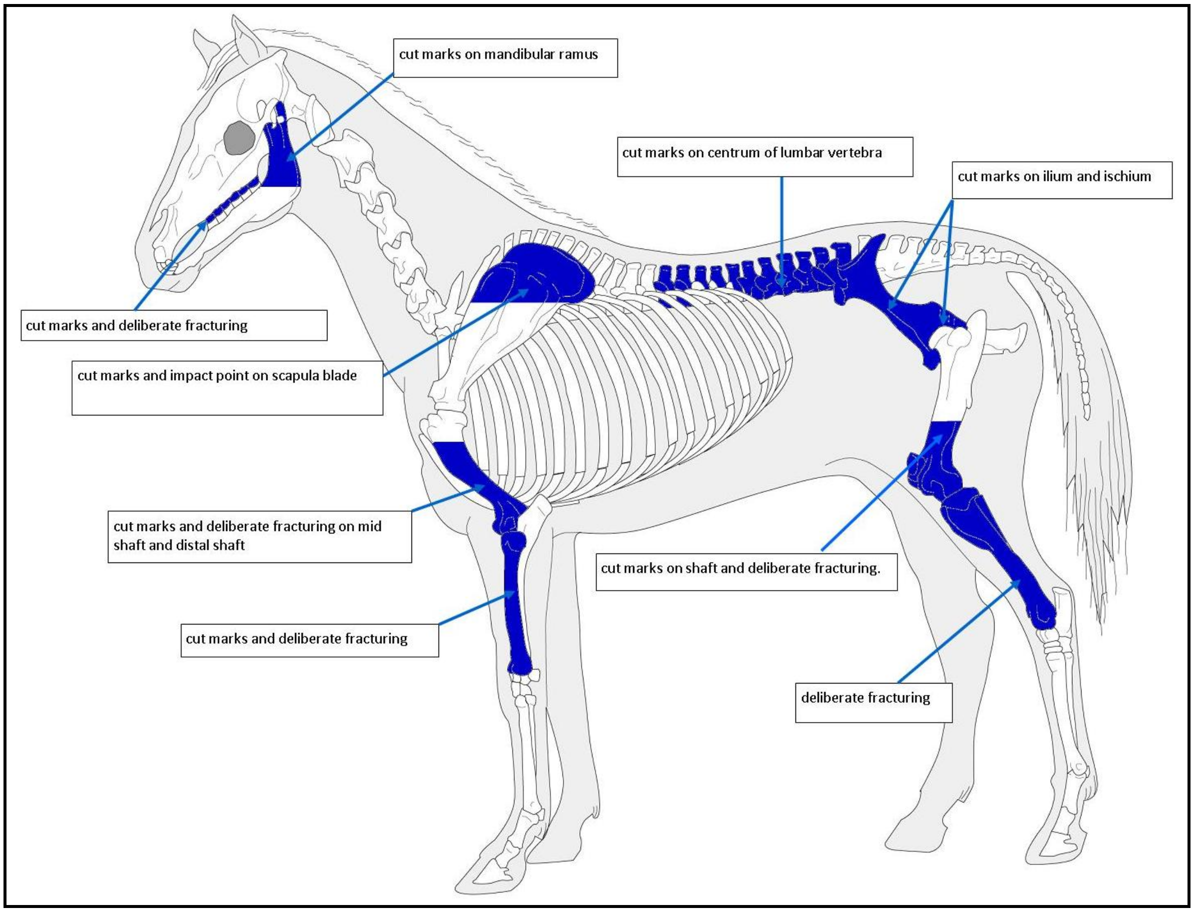

Figure 5.35 Distribution of hominin modification across equid skeleton
Skeletal outline modified from Yvinec *et al* (2007)

Cut marked teeth suggest that the mandible was disarticulated from the cranium to provide easier access to both jaw muscle and the tongue. Broken tooth roots indicate deliberate fracturing of the mandible for marrow-processing (see Figure 5.36), and this modification fits well with evidence of defleshing on the skull, presumably to provide easier access to the cranial vault (Parfitt, 1999a). Modification on and around the cranium suggests that this region was intact, which allowed hominins to exploit the meat, tongue, marrow and brain.

The preservation of cut marks on the vertebral column suggests primary access to the carcass and the filleting of meat from this region (see Figure 5.37).

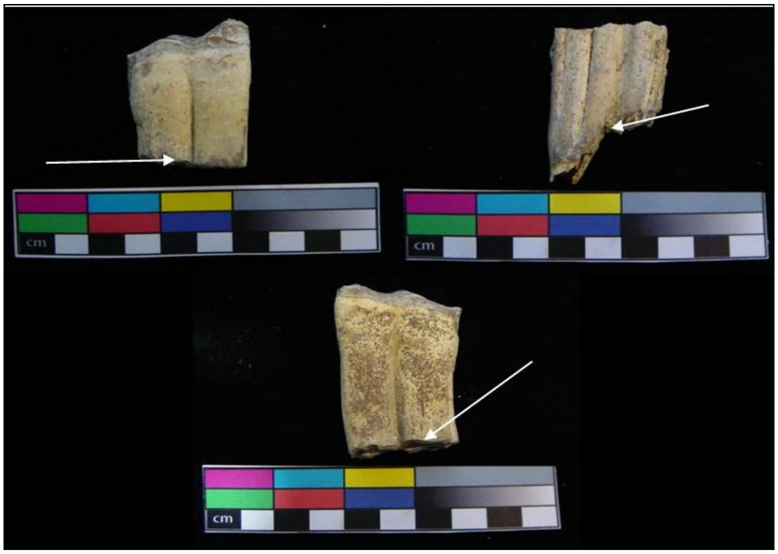

Figure 5.36 Hominin deliberate fracturing of horse molars

The area of bone highlighted by the white box is enlarged below

Figure 5.37 Hominin cut marks on centrum of horse lumbar vertebra

Filleting marks on the scapula blade demonstrates meat removal from the shoulder region, and cut marks on the scapula neck were caused during the disarticulation of the scapula/humeral joint. Cut marks on a humeral fragment suggest the filleting of meat from this bone prior to the deliberate fracturing of the shaft for marrow (see Figure 5.38). The radius shaft preserves extensive evidence for skinning and defleshing prior to deliberate fracturing and marrow-processing.

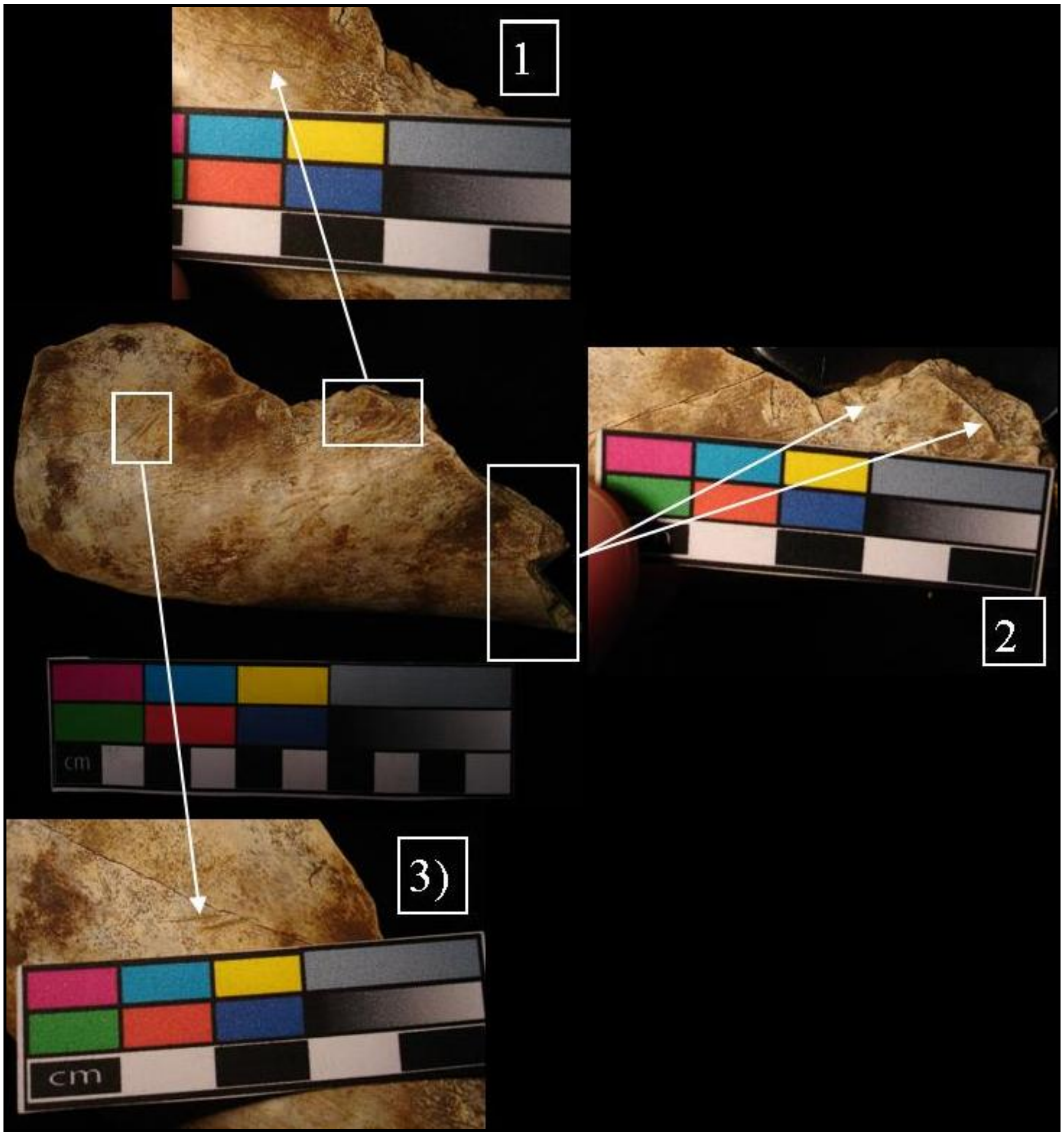

Figure 5.38 Equid humerus with multiple hominin modification signatures Including cut marks (1 & 3) and deliberate fracturing (2)

The scapula blade preserves evidence of an impact point and further studies have demonstrated that significant force was needed to have caused the breakage recorded on the scapula blade (Roberts and Parfitt, 1999b; Smith, 2003b) (see Figure 5.39). The impact notch on the horse scapula from GTP 17 suggests that this individual may have been actively hunted by Lower Palaeolithic hominins.

Figure 5.39 Horse scapula (BOX F277) from GTP 17 with impact point

Cut marks located on the acetabulum and ilium suggests the pelvis and femur were disarticulated and rump meat removed (see Figure 5.35). Hominin modification of the pelvis is overlain by predator-scavenger modification, which indicates primary access to this carcass by hominin communities. Filleting marks on the femur shaft indicate primary butchery and meat removal with subsequent deliberate fracturing of the same element to access bone marrow. Cut marks on the femur distal epiphysis provide evidence of femur/tibia disarticulation, perhaps to make marrow extraction from the femur easier (see Figure 5.40). Similar modification of horse remains away from GTP 17 includes the deliberate fracturing of a tibia shaft for marrow. The absence of initial skinning/defleshing modification on this element perhaps suggests secondary access to the carcass of an animal that died naturally.

Figure 5.40 Cut marks on femoral distal epiphysis (BOX F488)

The horse remains at GTP 17 suggest a relatively complete individual and evidence from the lithic debitage refitting and hominin bone surface modification indicate a discrete single episode event. The quantity and distribution of hominin modification at GTP 17 highlights primary access to all carcass nutrients including meat, tongue, brain and marrow. The limited predator-scavenger modification and the scapula impact point suggest an active procurement strategy, possibly through hunting. The presence of refitting lithic debitage from all stages of the *chaîne operatoire* indicates that hominins had primary access to this carcass, with sufficient time to thoroughly butchery the remains and also the ability to keep other large predator-scavengers away. This conclusions supports, and supplements, previous interpretations of the faunal and lithic material at GTP 17 (Pope and Roberts, 2005; Pope, 2002; Roberts, 1999a; Roberts and Parfitt, 1999b).

5.6 Bovid

5.6.1 Bison

Bison remains comprise a small number of specimens (NISP= 19; 2.3%)[5] from both cranial (9%) and post-cranial (91%) skeleton, although the cranial remains are represented by a single molar (see Appendix 2 Table 33 and 34; Figure 5.41 and Figure 5.42). The number

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[5] This figure includes the identifiable bison remains and bovidae sp.indet

of vertebral specimens is small (NISP= 5) but all portions are present including the denser centrum and the less dense spinous processes. The rib cage is represented by a single fragment of the proximal epiphysis and shaft (see Appendix 2 Table 35).

All portions of both the humerus and radius were identified (see Appendix 2 Table 36) whilst the only portions of the femur and tibia recorded were the denser shaft and distal epiphysis. The distal extremities are represented by the proximal and distal epiphyses of two metacarpals along with a complete 2nd phalanx and cuneiform, and which equate to a small number of elements and individuals (MNE= 1; MNI= 1).

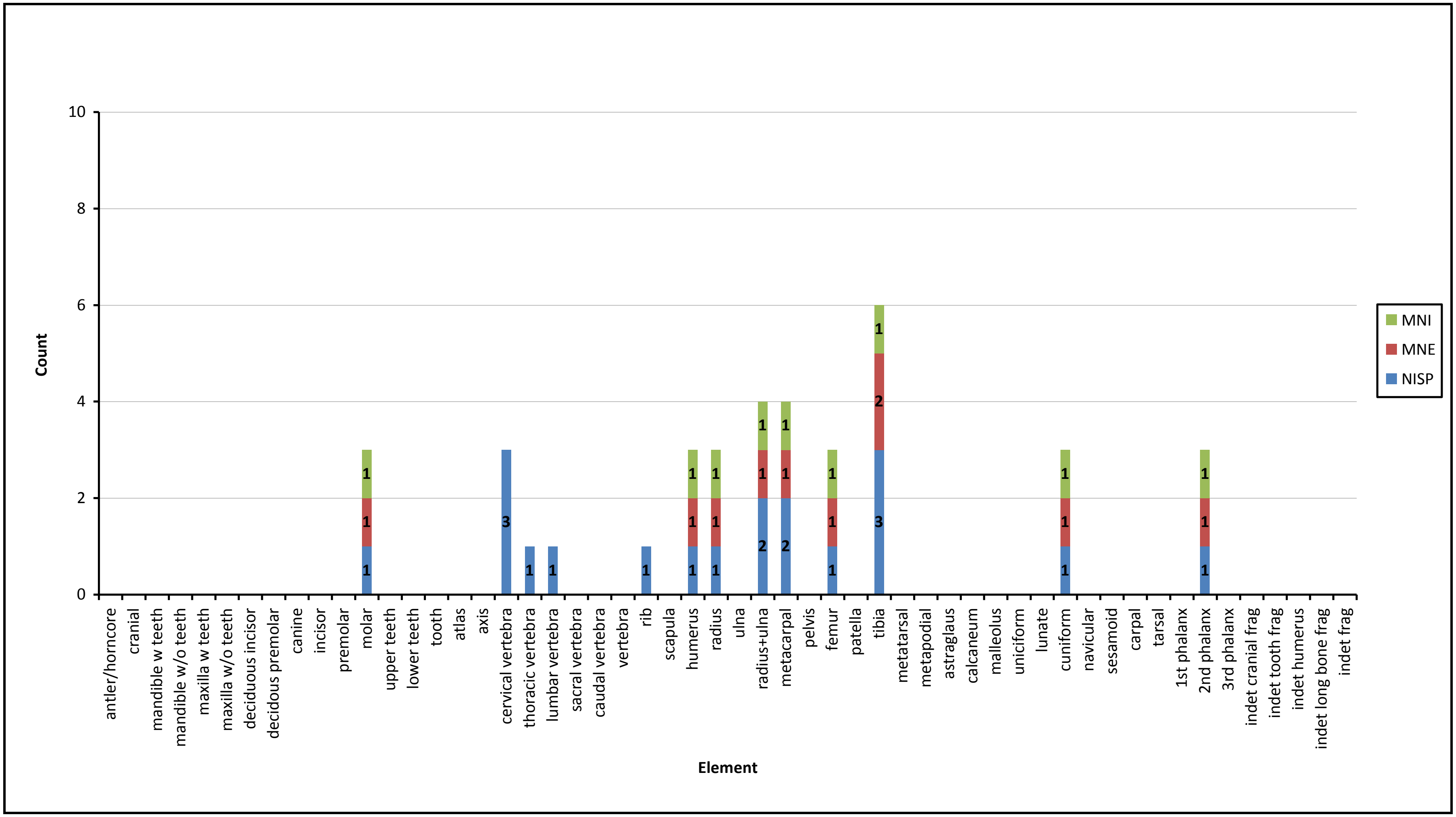

Figure 5.41 Bison (including Bovid sp.indet) NISP, MNE and MNI counts

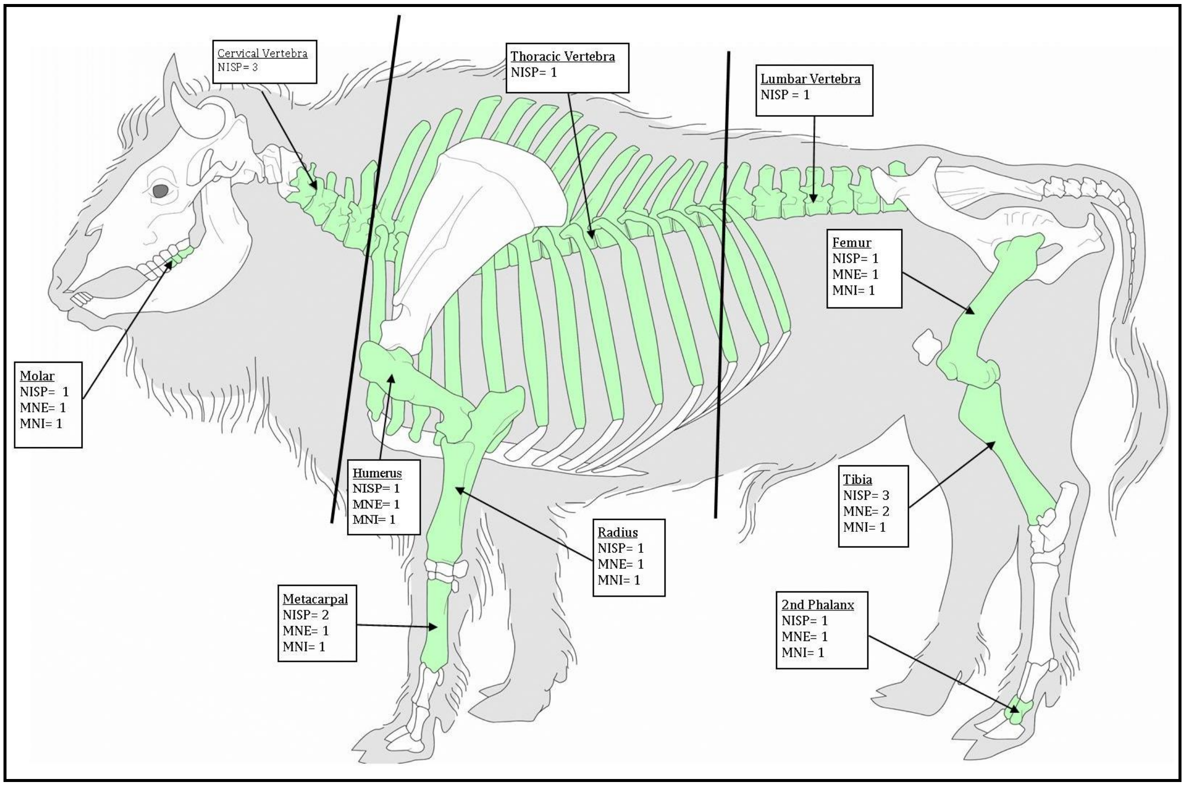

Figure 5.42 Bison skeletal representation with NISP, MNE and MNI values
Skeletal outline modified from Yvinec *et al* (2007)

The small assemblage size makes investigations into the impact of bone density on skeletal representation difficult. The identification of both dense and less dense bone portions could indicate the attritional removal of skeletal elements over a longer period of time by a variety of taphonomic agents such as predator-scavengers and hominins.

Predator-scavenger modification

Modification by non-human carnivores was identified on cervical and lumbar vertebra by the presence of tooth pits and scratches (see Figure 5.43 and Figure 5.44), which demonstrates prolonged tooth contact with these elements and the disarticulation of the vertebral column. Predator-scavenger modification on the cervical vertebra also suggests that meat was still available on the neck, and the identification of a cut mark on one of these specimens provides evidence of competition for these resources; although, it was not possible to ascertain whether hominins or predator-scavengers had primary access.

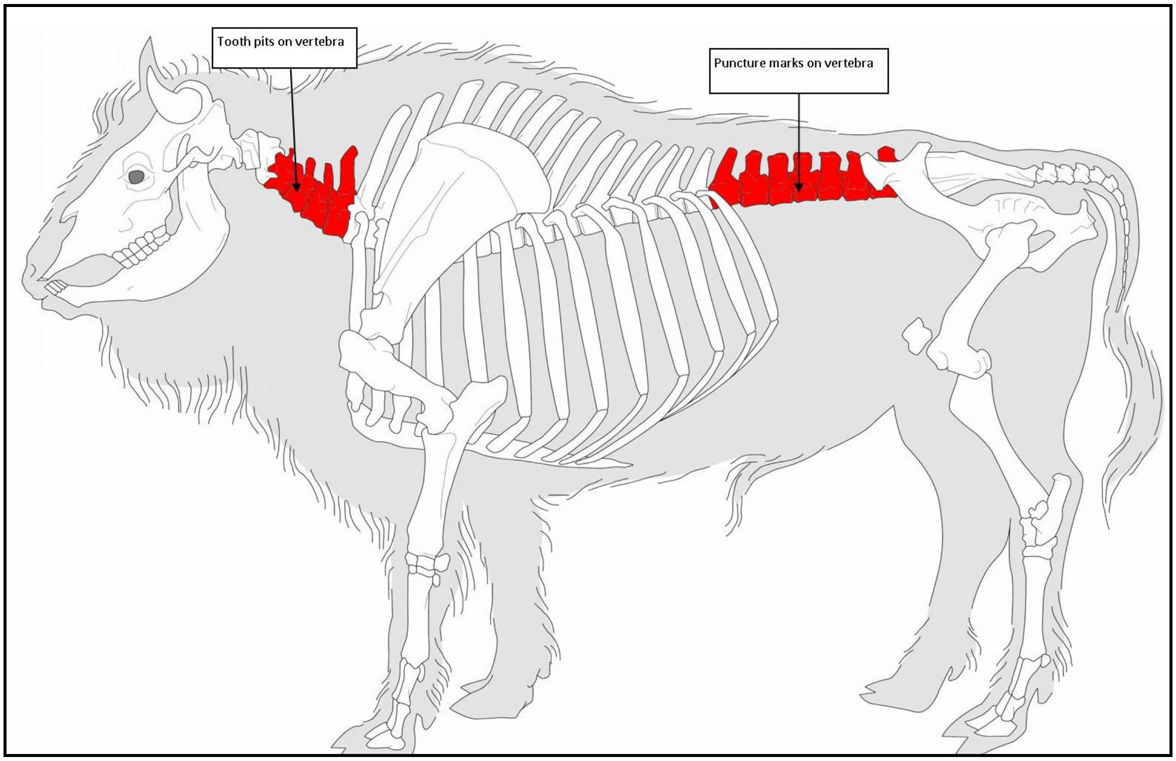

Figure 5.43 Distribution of predator-scavenger modification across bison skeleton
Skeletal outline modified from Yvinec *et al* (2007)

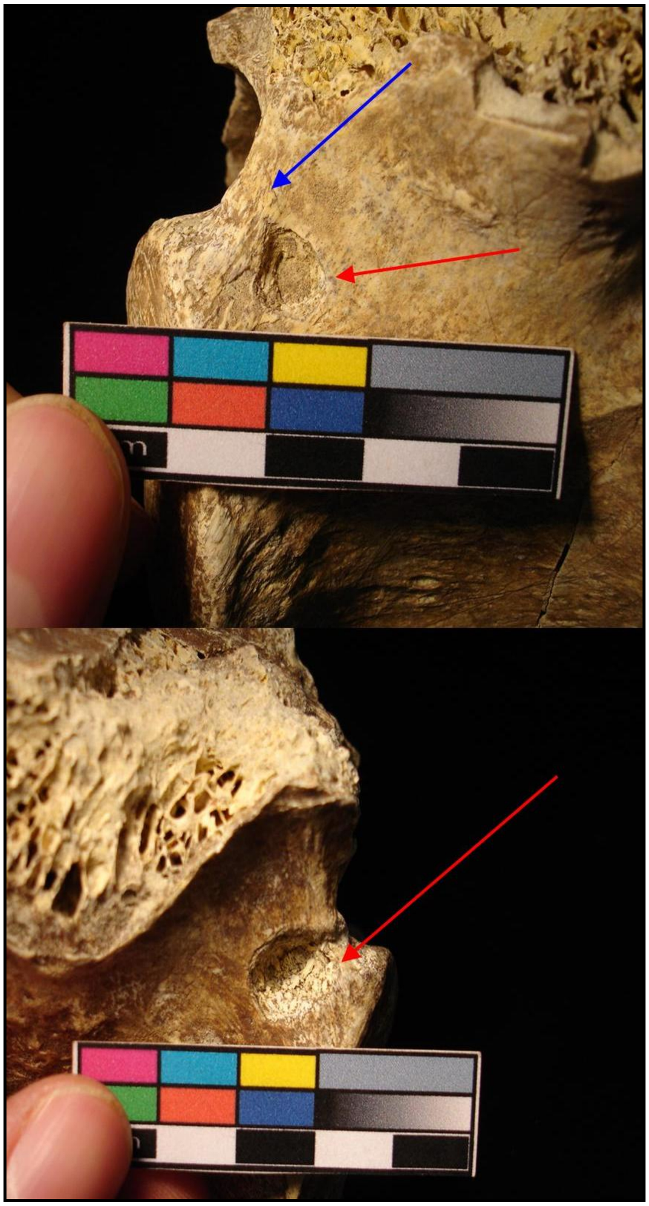

Figure 5.44 Predator-scavenger tooth pits on cervical vertebra (BOX F5636). Red arrow indicates tooth pits; Blue arrow indicates hominin cut mark

Hominin modification

A cut marked vertebra suggests that hominins were removing small amounts of meat from the cervical region and were in direct competition with other predator-scavenger species (see Figure 5.45 and Figure 5.44). The cut marked tibia provides evidence for the skinning and defleshing of this element by hominin communities prior to the deliberate fracturing of the shaft to exploit the marrow (see Figure 5.45). The type and distribution of hominin modification identified on bison remains suggests that these remains were natural deaths that were subsequently exploited by predator-scavengers and hominins for resources such as bone marrow.

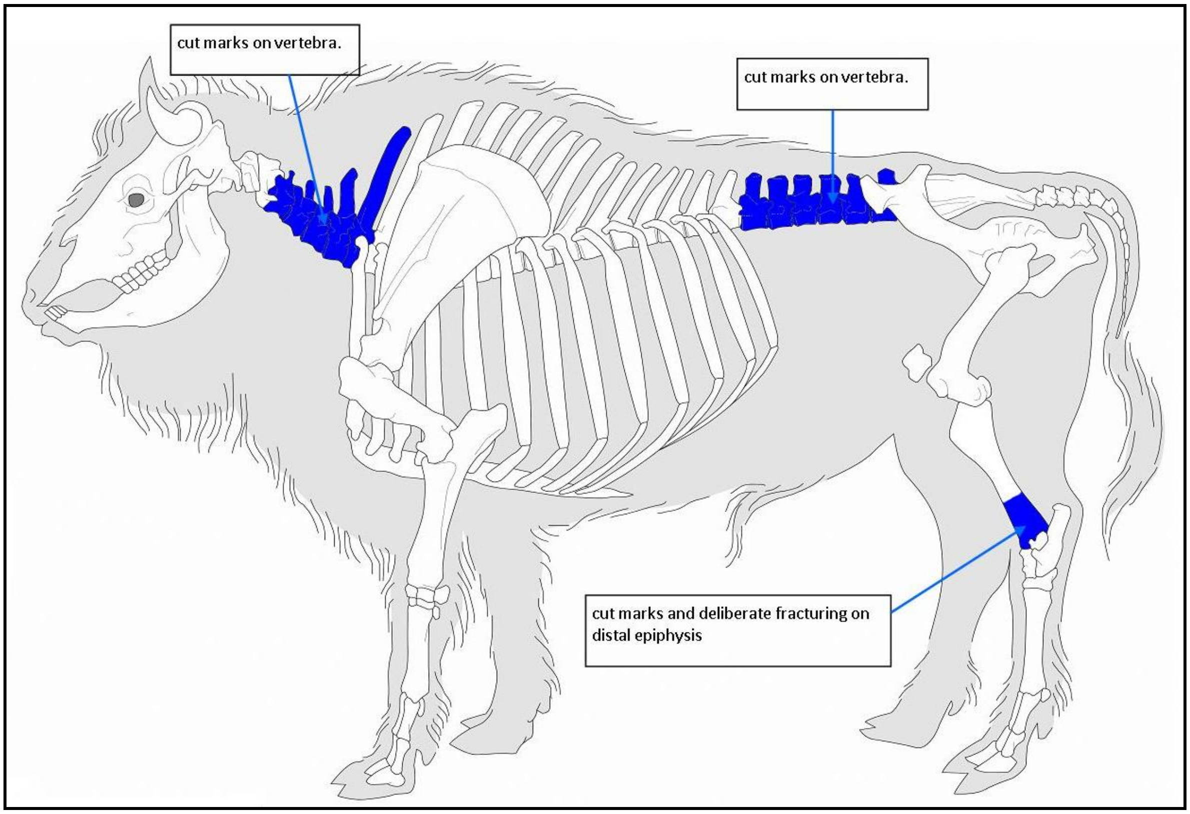

Figure 5.45 Distribution of Hominin modification across bison skeleton
Skeletal outline modified from Yvinec et al (2007)

Figure 5.46 Hominin deliberate fracture of bison tibia (BOX F7413) highlighting impact point

5.7 Megafauna

5.7.1 Extinct rhinoceros (*Stephanorhinus hundsheimensis*)

Stephanorhinus hundsheimensis is the most common megafaunal species (NISP= 39; 4.7%) (see Figure 5.47) with a range of cranial and post-cranial skeletal elements, represented in approximately equal quantities (see Appendix 2 Table 37 Figure 5.48 and Figure 5.49). Cranial specimens are dominated by dental remains though there is some representation of non-dental portions (see Figure 5.49), with some elements, such as the maxilla heavily fragmented, and corresponding to a small number of individuals (MNI= 1).

The axial skeleton is poorly represented (NISP= 1), and it is interesting that rhino vertebral specimens are less common compared with certain medium-sized species, such as red deer. It was expected that meagafaunal elements were denser and thus would have been more prevalent, although some specimens recorded as indeterminate large mammal may represent the fragmented remains of various megafaunal skeletal elements.

The scapula is recorded by a single specimen, which contrasts with the heavily fragmented pelvis (NISP= 8; MNE= 2; MNI= 2) (see Figure 5.48 and Appendix 2 Table 38 & 39). The upper forelimb is represented by a large number of specimens (NISP= 5) that have been heavily fragmented and hence correspond to a smaller number of elements and individuals (humerus MNE=1; MNI= 1) (see Appendix 2 Table 40). The ulna has a similarly small number of specimens with limited fragmentation and a small number of individuals (NISP= 2; MNI= 1). The hind limb is poorly represented by a single, complete patella and tibia fragment resulting in a reduced MNE/MNI value (MNE=1; MNI= 1). The extremities are represented by three complete tarsal bones and a complete 3rd phalanx.

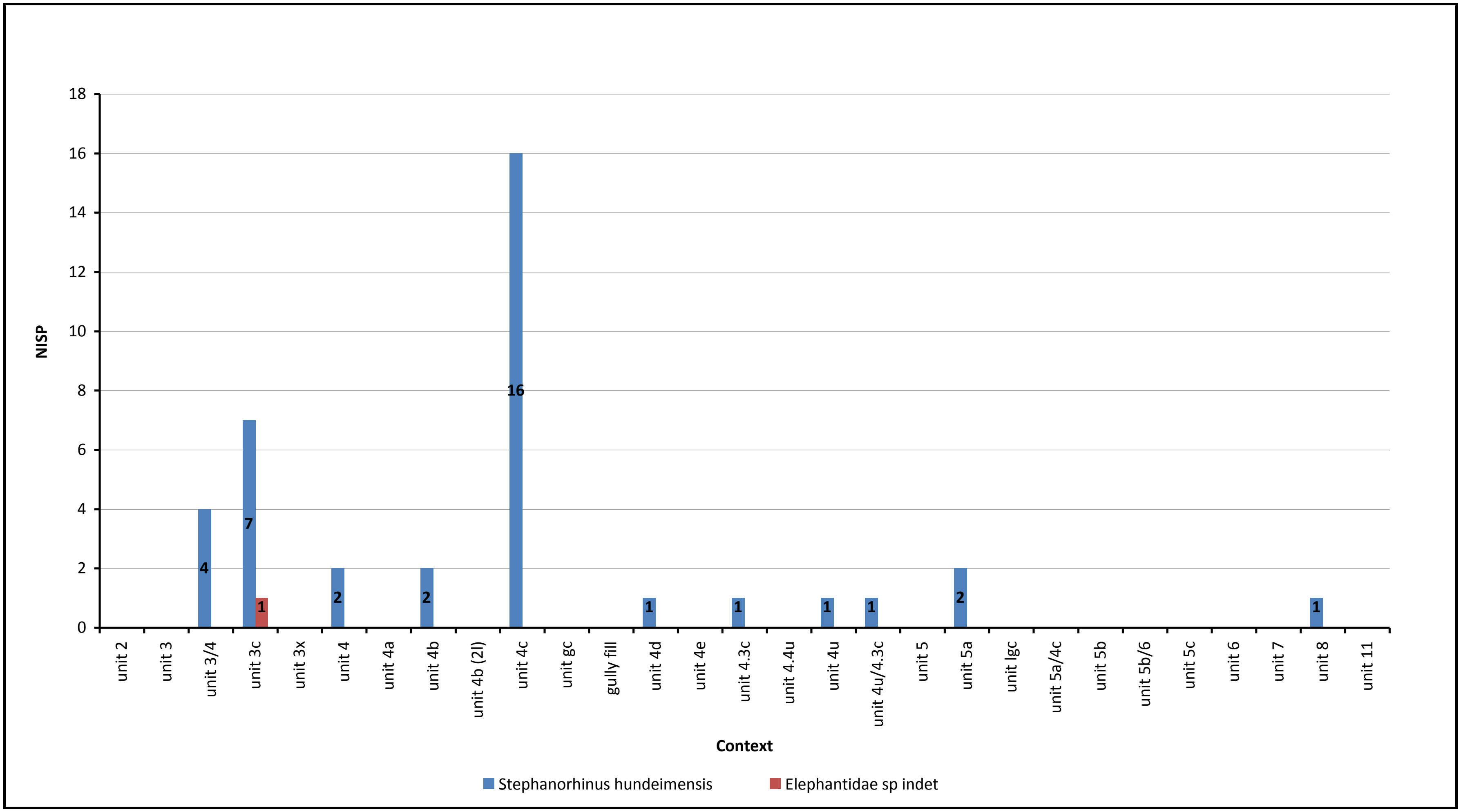

Figure 5.47 Distribution of Megafauna throughout the major Boxgrove contexts

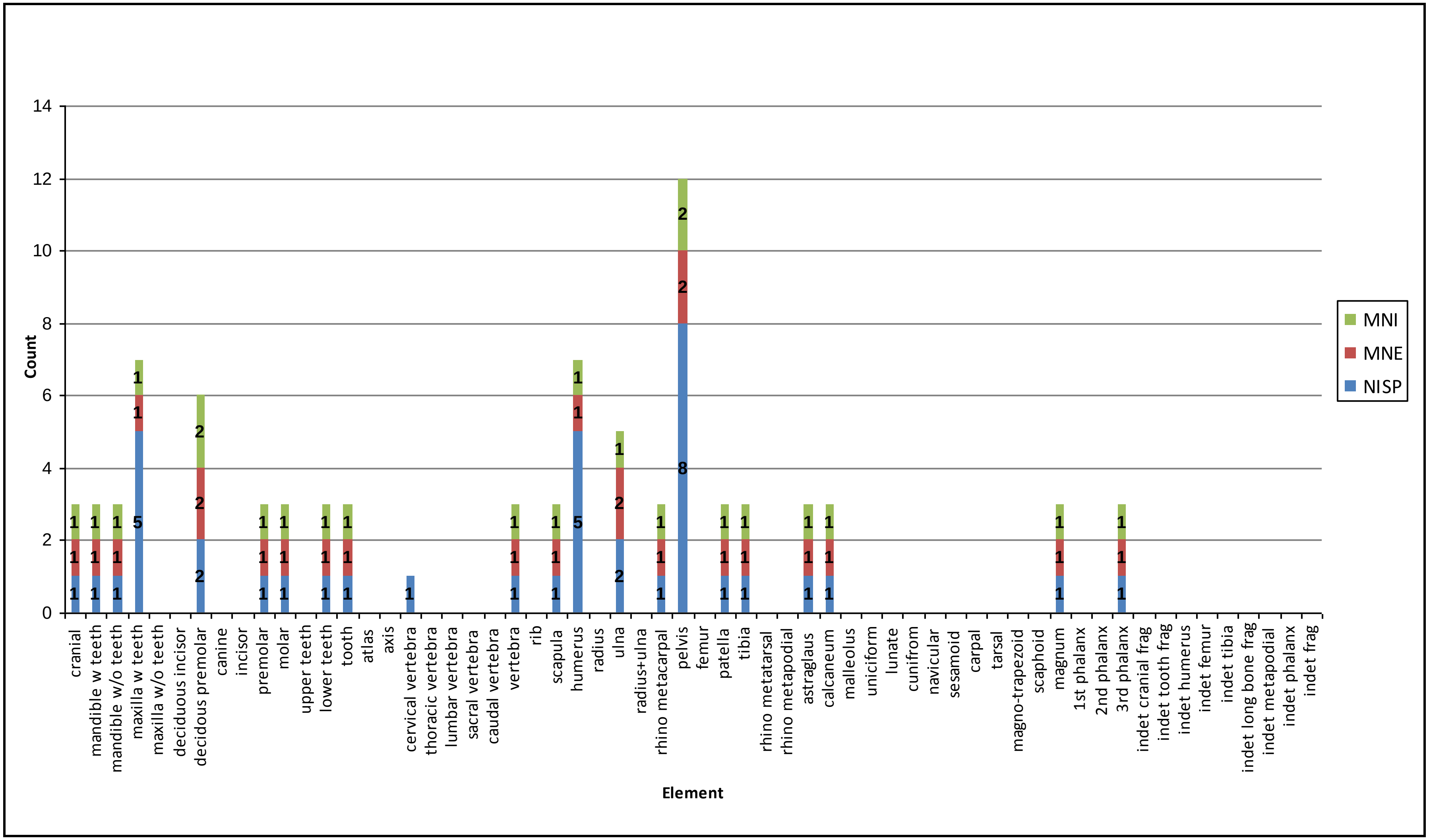

Figure 5.48 Rhinoceros NISP, MNE and MNI values

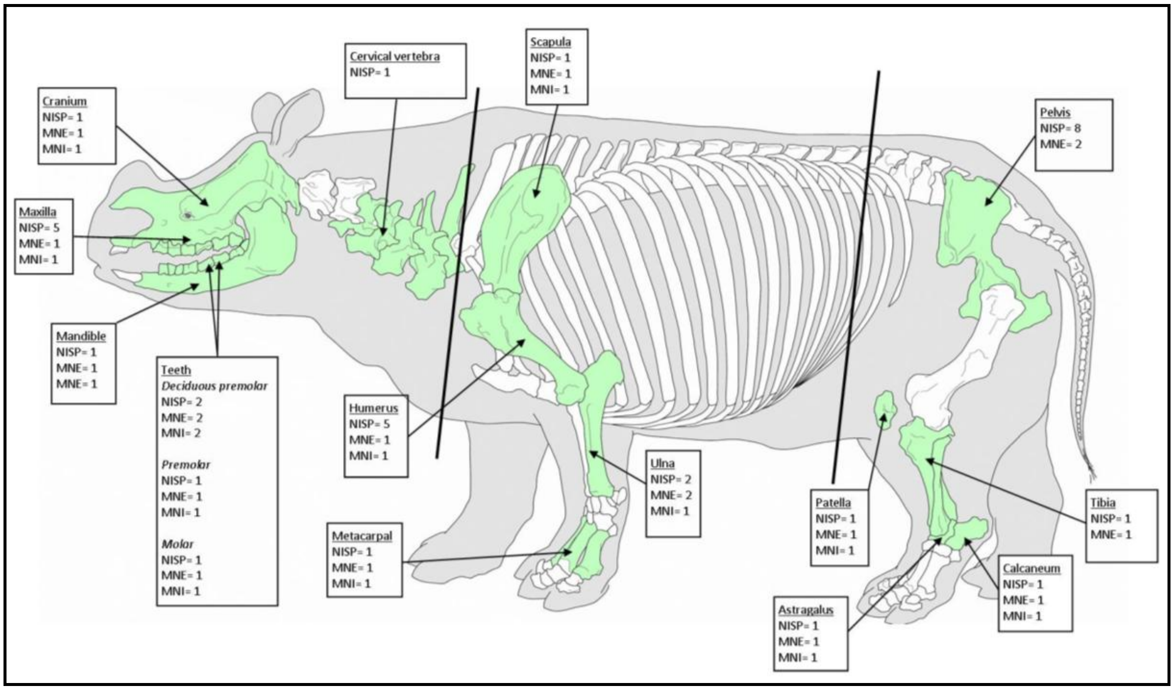

Figure 5.49 Rhino skeletal representation with NISP, MNE and MNI values
Skeletal outline modified from Yvinec *et al* (2007)

Both cranial and postcranial elements are displayed in the rhino skeletal part profile with evidence for some fragmentation, which consequently relates to a small number of individuals (MNI= 2). There is some evidence for the differential destruction of less dense skeletal elements, though the denser regions are by no means preserved in larger quantities, which perhaps suggests that the rhino remains have accumulated attritionally as a result of natural deaths.

Predator-scavenger modification

Predator-scavenger crenelation on a humeral shaft indicates marrow exploitation (see Figure 5.50 and Figure 5.51) and the location of modification suggests a species with strong masticator ability, such as a hyaena. The absence of tooth scratches suggests that a limited amount of meat was available on this element. Evidence of predator-scavenger modification, combined with hominin butchery signatures, suggests that non-hominin carnivores only exploited the bone marrow once hominins had removed the meat and other resources from the carcasses (see below).

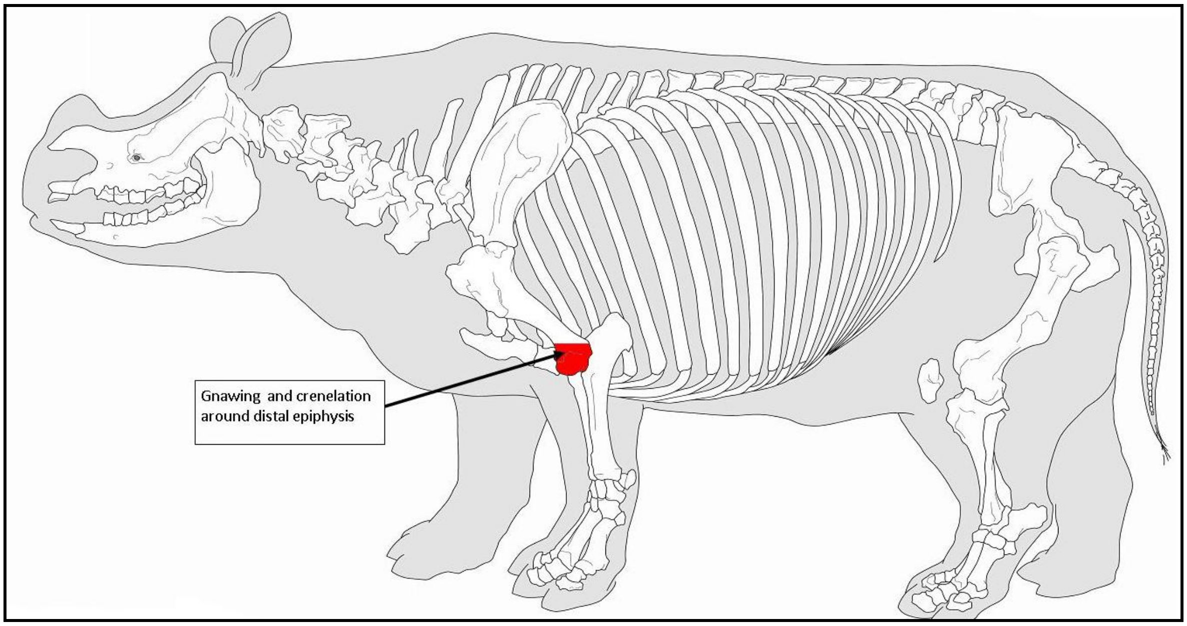

Figure 5.50 Distribution of predator-scavenger modification across rhino skeleton
Skeletal outline modified from Yvinec *et al* (2007)

Figure 5.51 Predator-scavenger crenelation on proximal rhino femur (BOX F64)

Hominin modification

Hominin modification of rhino remains is distributed across the cranial and post-cranial skeleton (see Figure 5.52 and Appendix 2 Table 41). Cut marks on the maxilla, mandible and molar suggest the disarticulation of the jaw from the cranium, to exploit the muscle mass on the lower jaw and the tongue. Cut marks on cranial fragments indicate skinning and defleshing of the skull, presumably to make it easier to exploit the brain (see Figure 5.53).

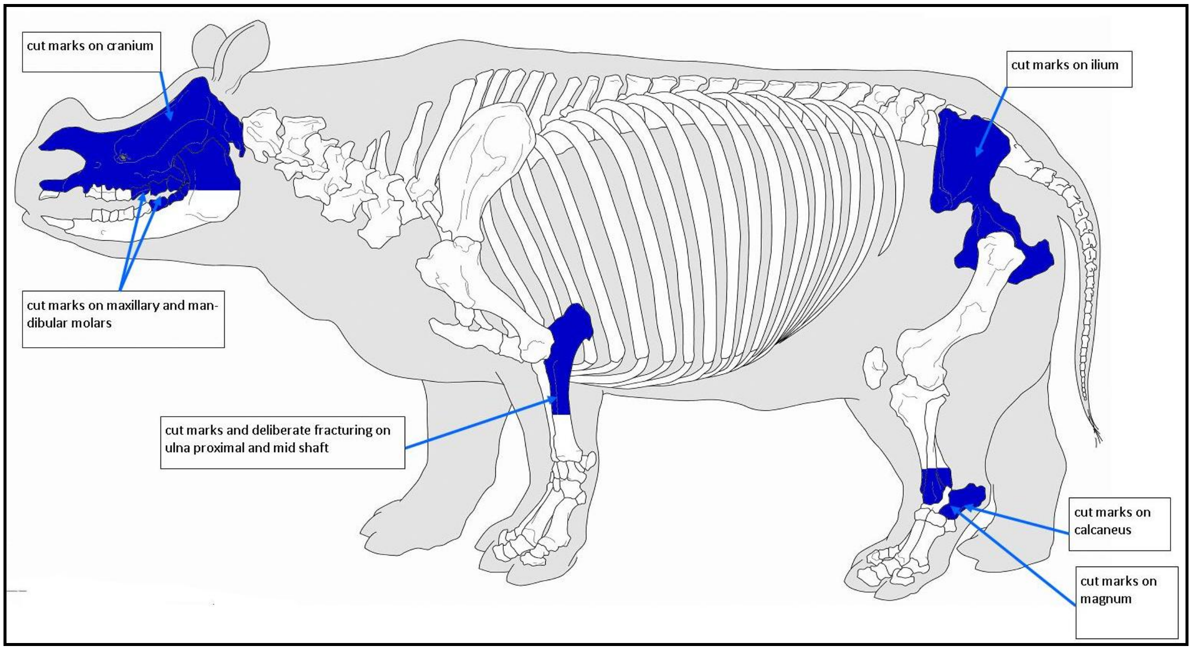

Figure 5.52 Distribution of hominin modification across rhino skeleton
Skeletal outline modified from Yvinec *et al* (2007)

Figure 5.53 Close up detail of cut marks on rhino cranium (BOX F7802)

Modification of post-cranial elements is mostly confined to the lower regions of the appendicular skeleton, although one pelvis fragmented is heavily cut marked (n= 35). This pelvis specimen has overlapping cut marks that indicate intensive butchery and removal of large quantities of meat (see Figure 5.54). The absence of cut marks around the acetabulum perhaps suggests that the femur was already disarticulated from this individual, and provides further support for the idea that these individuals were natural deaths. The cut marks and deliberate fracturing of a radius and tibia are evidence for skinning and defleshing of this element prior to marrow-processing.

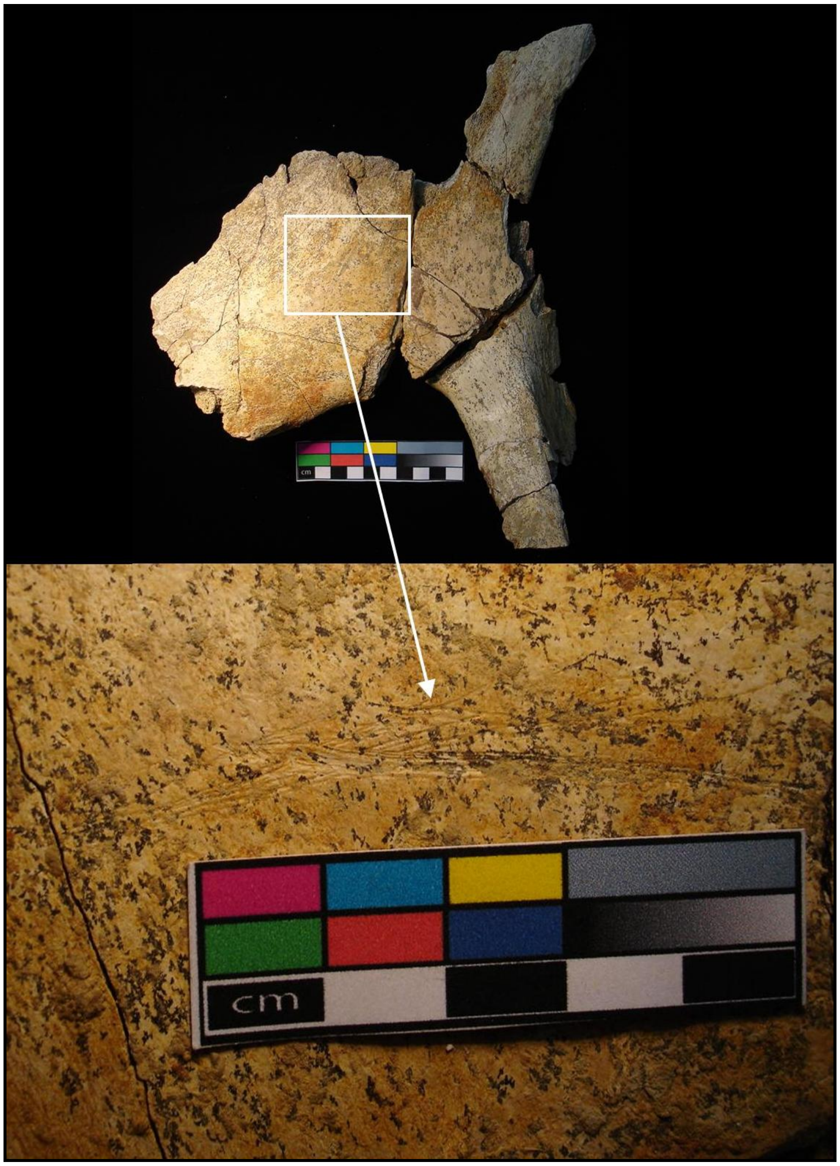

Figure 5.54 Rhino pelvis (BOX F11) with extensive, overlapping cut marks
Part of the white square is shown in more detail in the bottom photo

Hominin cut marks and predator-scavenger gnawing and tooth pits were identified on a rhino calcaneum and provide important information about relative timing of access for hominin and non-hominin carnivores. The presence of cut marks on the calcaneum, close to the areas of muscle and tendon attachment are consistent with evidence of disarticulation and dismemberment (see Figure 5.55). The gnawing of the calcaneus head by carnivores suggests that this occurred after the element had been disarticulated by hominins, and the presence of a cut mark, truncated by a carnivore tooth pit indicates involvement subsequent to primary hominin carcass-processing.

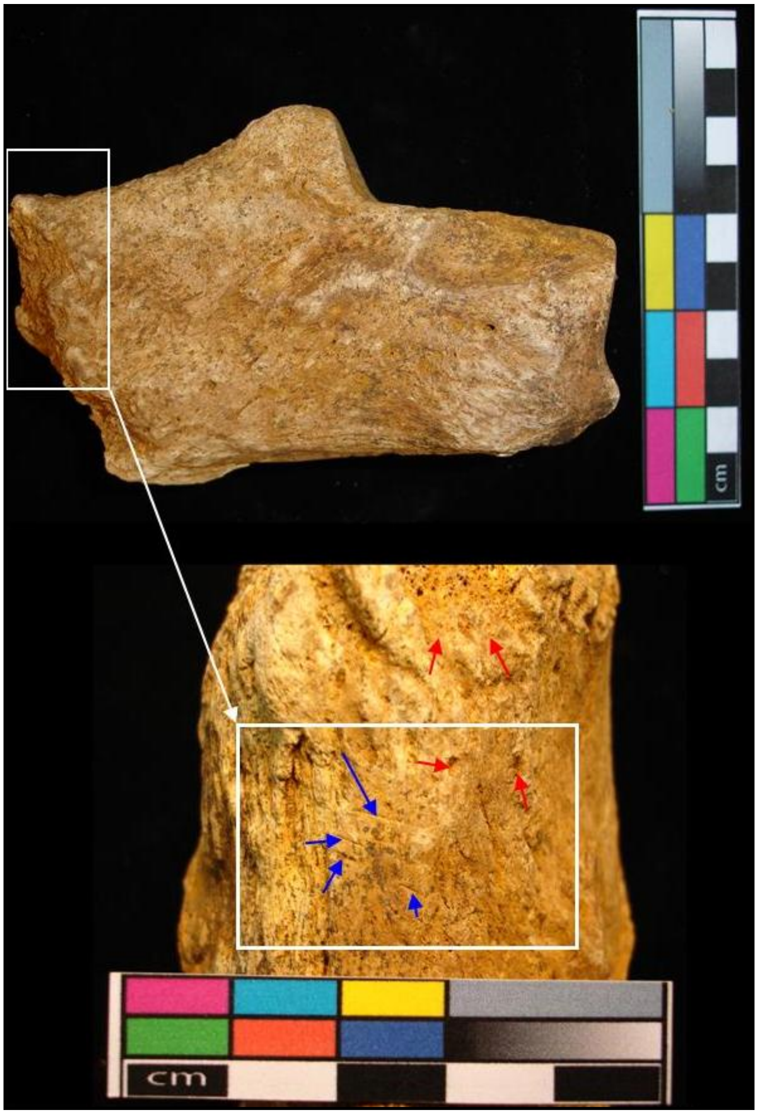

Figure 5.55 Hominin cut marks and predator-scavenger gnawing and tooth pits on rhino calcaneum Blue arrows indicate hominin modification, red arrows are predator-scavenger modification.

5.7.2 Elephant sp. indet

Elephant remains are represented by a single femur proximal shaft and the absence of predator-scavenger or hominin modification suggests that the faunal remains accumulated as a result of natural mortality.

5.8 Indeterminate Species

5.8.1 Large mammal

Large mammal remains are dominated by indeterminate long bone and indeterminate fragments (see Appendix 2 Table 42 and see Figure 5.56), though other cranial and post-cranial remains are represented. Cranial remains are poorly represented within the faunal assemblage and only identified through mandibular fragments and a deciduous premolar. The axial skeleton is only preserved by thoracic vertebra fragments and other fragments of indeterminate element and portion. A large number of both proximal epiphysis and shaft fragments comprise the rib cage component of the large mammal assemblage. The appendicular skeleton is represented by few specimens whilst the podials, metapodials and phalanges are accounted for by a single tarsal and phalanx.

None of these specimens could be assigned to species and hence each fragment could relate to a different genus. The absence of vertebra from the skeletal profiles of some species, such as roe deer and horse, could be a function of heavy fragmentation, which prevented accurate identification of these fragments to species and, as a consequence, these specimens were recorded as indeterminate. The absence of ribs from the skeletal profiles of some large/medium sized species could similarly be a function of heavy bone fragmentation, which has prevented accurate species determination. The large number of indeterminate specimens highlights fragmentation of the faunal assemblage; correspondingly, the amount and distribution of hominin and predator-scavenger modification suggests that such fragmentation resulted from the actions of these taphonomic agents.

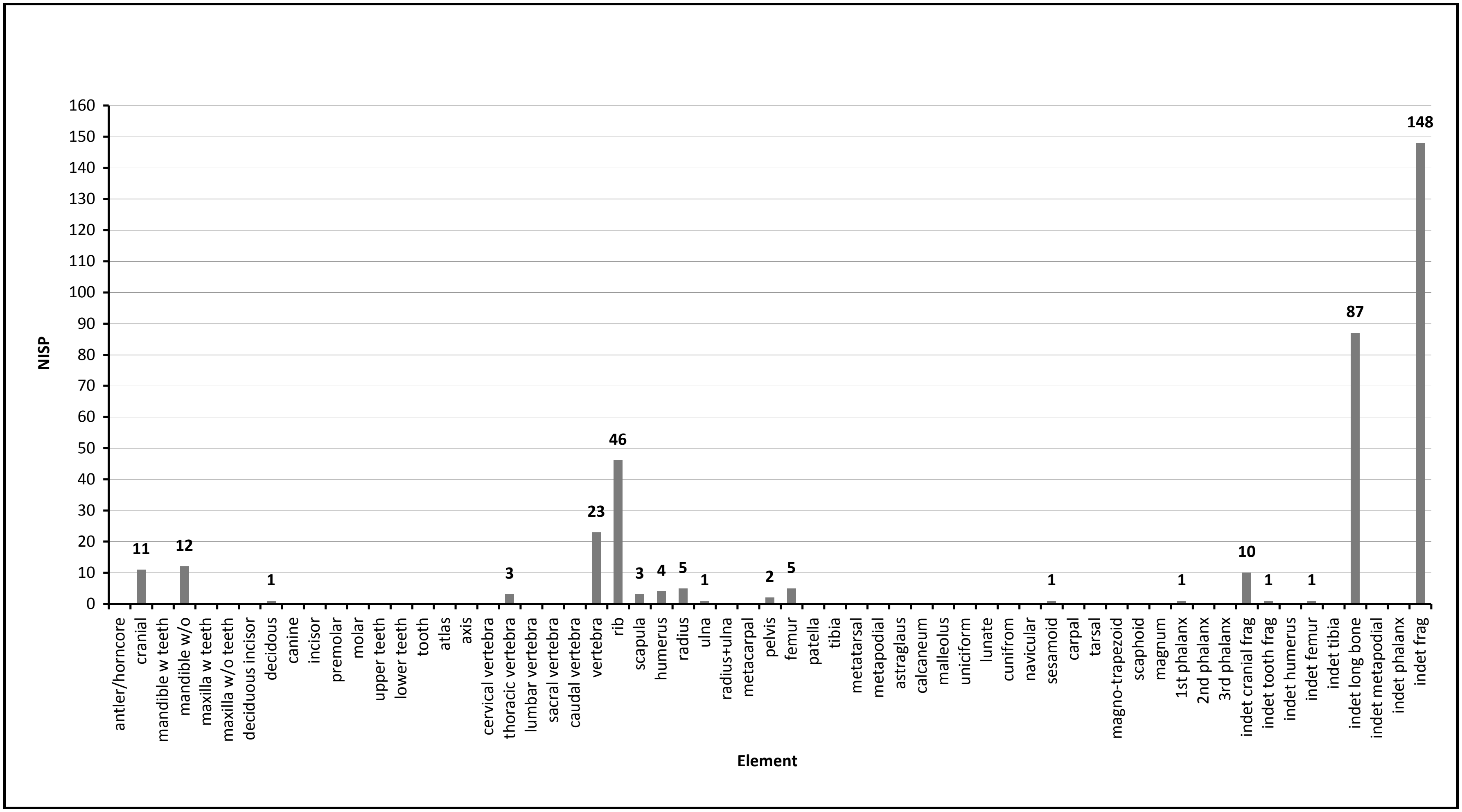

Figure 5.56 Large mammal NISP

Predator-scavenger modification

Predator-scavenging gnawing of a humerus distal shaft is indicative of exploitation for marrow; with similar evidence modification highlighted on an indeterminate long bone specimen. Tooth pits on two indeterminate fragments demonstrate prolonged tooth contact and are related to the gnawing of these specimens to access marrow or bone grease; a similar modification signature was identified on a radius shaft fragment. Tooth pits on rib shafts are similar to those identified by Binford during modern ethnographic work in the Arctic (Binford, 1981). The tooth pits demonstrate sustained tooth contact with the element and their location provides evidence that small portions of meat were still available in this region, a view supported by the identification of cut marks on the same specimen. Predator-scavenger puncture wounds on the scapula head relate to the disarticulation of the scapula/humeral joint, and suggest that predator-scavengers had access to a relatively articulated carcass with significant quantities of muscle mass still attached.

Hominin modification

The quantity and variation of hominin modification on the large mammal assemblage suggests that faunal assemblage fragmentation may relate directly to the butchery practices of hominins and predator-scavengers. It is important to remember that these elements could relate to numerous large/medium-sized species identified at Boxgrove and therefore the analysis should be considered alongside other hominin modification highlighted previously rather than as separate and discrete behaviour.

Cut marked cranial elements suggest skinning and defleshing of the skull to access the brain (see Sections 5.5.1 and 5.7.1). Hominin modification on indeterminate fragments illustrate considerable variation with evidence for chop, skinning and filleting marks as well as deliberate fracturing often on the same specimens. Such variation in behavioural signatures suggests that many of these bone fragments relate to relatively complete carcasses that have subsequently been fragmented through both hominin and predator-scavenger exploitation. Cut marked vertebral specimens provide evidence for disarticulation and suggest that carcasses were relatively articulated (see Figure 5.57). Cut marks on rib heads and shafts highlight evidence of meat removal from this region and disarticulation of the rib cage the spinal column to access the internal organs or transport meat off site.

Figure 5.57 Cut marks on indeterminate vertebral fragment

Cut marks on the scapula blade and pelvic ilium suggest processing for meat products, again indicative of articulated carcasses. Deliberate fracturing of the fore and hind limbs suggests exploitation for marrow, though cut marks on the femur shaft suggests the prior removal of meat. The marks also indicate that these elements were relatively complete and the fragmentation relates to subsequent hominin and predator-scavenger carcass-processing (see Figure 5.58). Cut marks on the lower forelimb portions (radius and ulna) suggest that these elements were skinned and defleshed to exploit the marrow, a process which has been documented for other numerous large/medium-sized species. Cut marks on the epiphysis of a 1st phalanx implies disarticulation of the limb extremities and further evidence that bone fragmentation is related to the disarticulation and butchery of these carcasses by hominins and/or predator-scavengers.

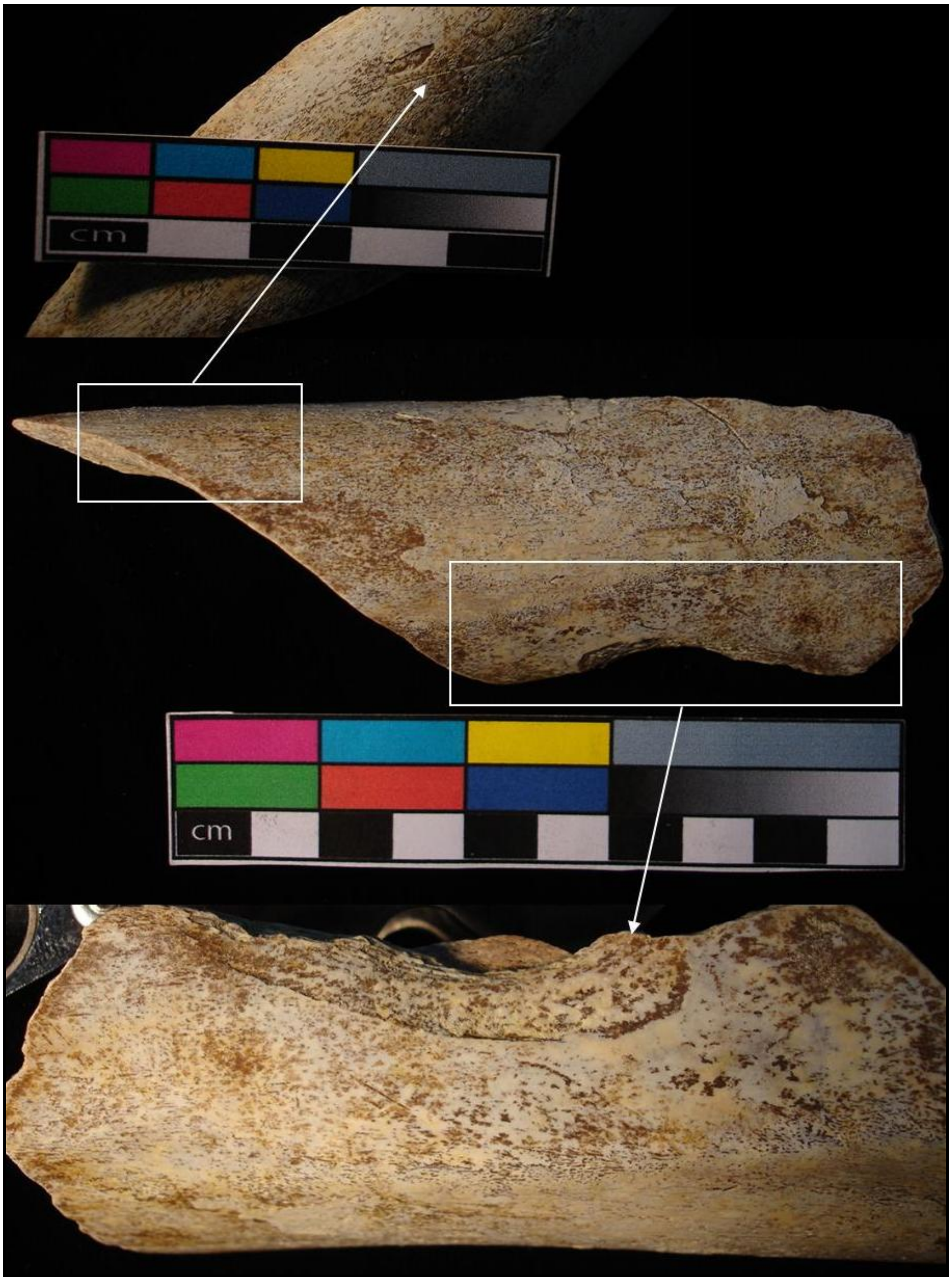

Figure 5.58 Cut mark and deliberate fracture on large mammal femur shaft fragment

5.8.2 Deer sized

This general category is based on the size of the specimen identified, and is again dominated by indeterminate fragments especially long bone fragments (see Figure 5.59). The majority of these indeterminate fragments are identified as dense shaft portions though some cranial and epiphyseal fragments are preserved. There are very few identifiable cranial or post-cranial elements recorded, although some of the less dense portions of the vertebrae are documented. A similar pattern can be observed on rib fragments where the less dense non-articular portions of the shaft are well preserved though these portions are more difficult to assign to a species. The appendicular skeleton shows a mixture of elemental survival with both shaft and epiphyseal portions represented. The presence of both denser and less dense elements indicates that skeletal representation is not the result of differential destruction/preservation of specific bone elements/portions.

Predator-scavenger modification

A single indeterminate long bone specimen preserves evidence of a predator-scavenger tooth pit and indicates either that meat was limited on this portion or gnawing to access the marrow cavity. The lack of other predator-scavenger modification makes it difficult to discuss a specific behaviours.

Hominin modification

The pattern of hominin modification appears similar to that highlighted for the large mammal fauna with a variety of modification from cut marks to deliberate fracturing. The inability to assign these specimens to a particular species prevents discussion of a specific strategy but appears to fit neatly with the modification highlighted for other species which demonstrates primary access for hominin communities to these carcasses and nutrients.

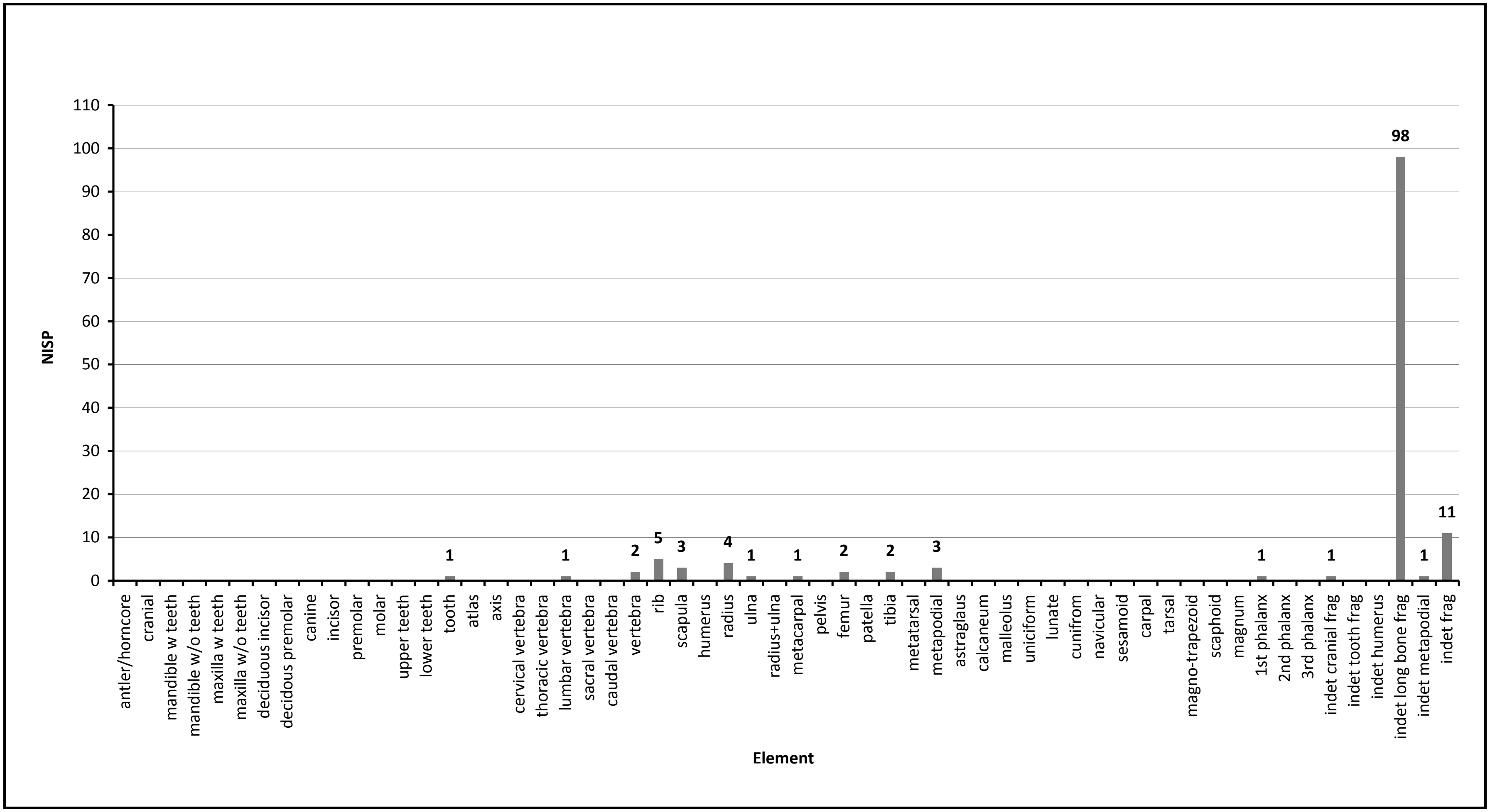

Figure 5.59 Deer sized NISP

5.8.3 Indeterminate species

This category is dominated by indeterminate long bone fragments though there are other indeterminate cranial fragments and postcranial fragments (see Appendix 2 Table 43 and Figure 5.60). Most of these indeterminate fragments can be assigned to a specific portion, namely the denser longbone shafts and due to the large numbers of fragments in this category it is very difficult to assess whether element survival was a function of relative bone density.

Predator-scavenger modification

Non-hominin bone modification is only identified on a single long bone specimen with tooth pits and gnawing indicative of marrow-processing.

Hominin modification

There is considerable variation in the type of modification with cut marks indicating the disarticulation and processing of elements for meat along with deliberate fractures and impact points that suggest exploitation for marrow. The hominin modification highlights primary access and although these specimens could theoretically apply to any of the large/medium-sized species it confirms the general modification pattern observed for other species.

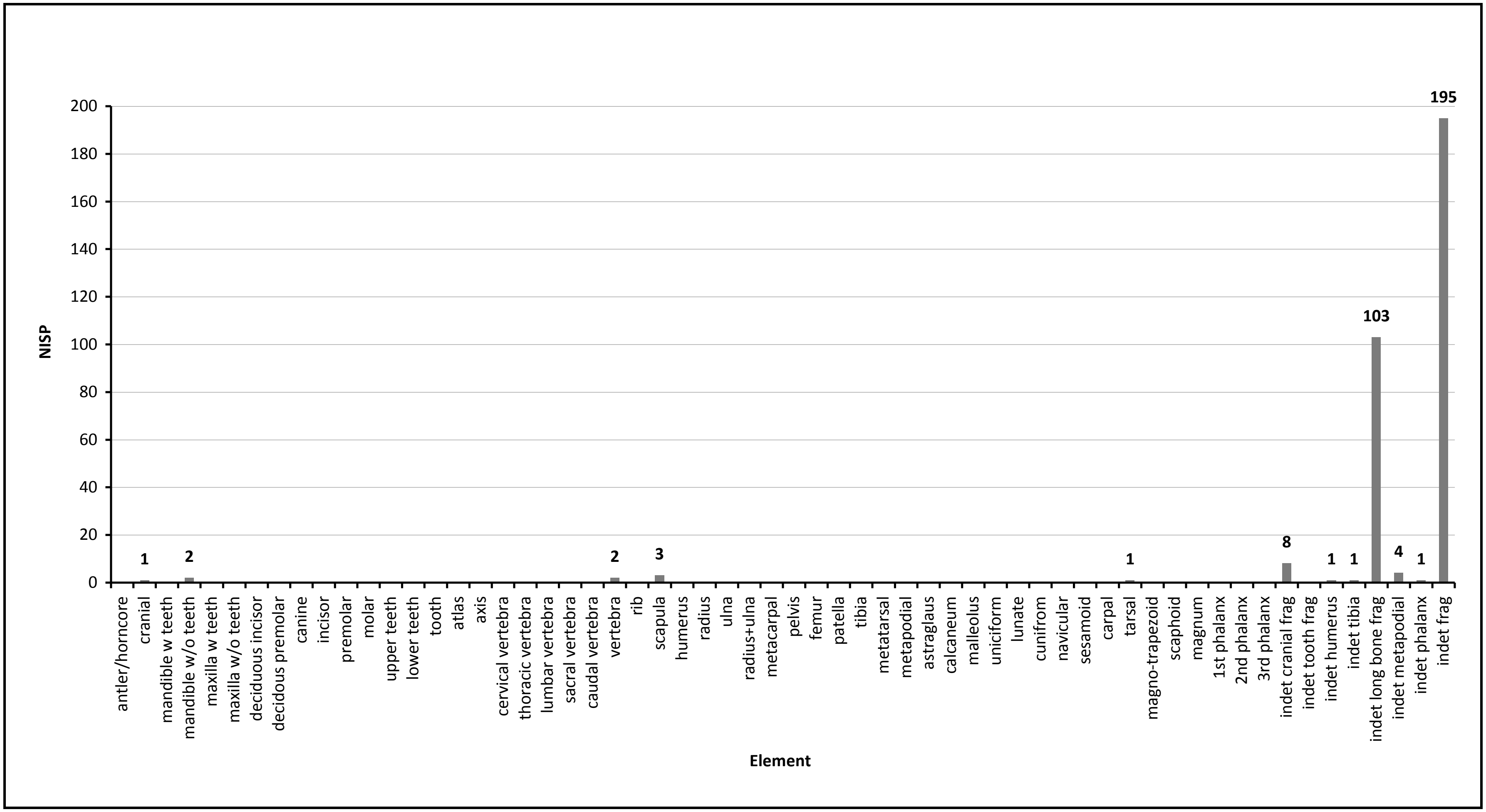

Figure 5.60 Indeterminate species NISP

5.9 Assemblage fracture patterns

Considerable fracturing has been identified throughout the assemblage and across numerous species (n= 46; see Table 5.3), though experimental observations have highlighted that numerous agents can produce similar fracture morphologies (see Bonnichsen and Sorg, 1989; Brain, 1981; Smith, 2003b). There are numerous different fracture types recorded on elements from the Boxgrove assemblage (see Table 5.3) including spiral, flaking, and perpendicular, with a majority assignable to a specific modification agent. Interestingly, the majority of fractures recorded are spiral (n=32) which indicates that the bone was broken when still fresh (Becker and Reed, 1993; Bonnichsen and Sorg, 1989; Lyman, 1994). There are very few brittle bone fractures (n=9), and when combined with other evidence of cultural and predator-scavenger modification suggests that these two agents were largely responsible for the fracture patterns observed throughout the assemblage.

As identified in the discussion above, the majority of the fractures assignable to a particular agent have been identified as a result of deliberate fracturing by hominins to access the marrow cavity (n= 33). The limited evidence for predator-scavenger marrow extraction (n=4) is similar to that identified for other types of modification across the faunal assemblage (see for example Figure 5.23 and Figure 5.58). The fracture patterns would appear to support previously discussed evidence and suggest that hominin populations appear to have had primary access to almost all carcass nutrients including the marrow.

In addition, the majority of the rounded fracture edges are from the channel deposits (n= 11) and indicate a sustained period of time submerged in water (see Table 5.3). However, as illustrated above the channel feature appears to have played a relatively insignificant part in the assemblage formation and modification compared with some other sites (see Chapter 7). The remainder of the fracture edge rounding appears to have been a result of submergence at the edge of the water hole or in the intertidal deposits. Fracture pattern analysis indicates that hominins were the major agent responsible for the fragmentation observed. The fracture patterns combined with the intensity and distribution of other hominin behavioural signatures, and the relative absence of predator-scavenger modification, indicates the primacy of hominin involvement in faunal accumulation at Boxgrove.

Species	Element	Fracture Type	Fracture Edge	Modification
bison (includes bovidae sp.indet)	radius	spiral	rounded	no
	metacarpal	Spiral	rough	no
	tibia	flaking	rough	yes
roe deer	femur	spiral	rough	no
cattle/horse sized	indet long bone	flaking	rough	yes
cervidae sp. indet	humerus	spiral	rough	no
	radius	spiral	rounded	no
	femur	spiral	rough	no
	femur	spiral	rounded	yes
	tibia	smooth perpendicular	rough	no
	tibia	spiral	rough	no
	metapodial	spiral	rough	yes
	metapodial	spiral	rough	no
deer sized	indet long bone	spiral	rough	yes
	indet long bone	spiral	rough	no
	indet long bone	spiral	rough	no
	indet long bone	spiral	rough	no
	indet long bone	spiral	rough	no
	indet long bone	spiral	rounded	yes
horse	upper premolar	irregular perpendicular	rough	yes
	upper molar	smooth perpendicular	rounded	yes
	upper molar	stepped or columnar	rough	yes
	upper molar	smooth perpendicular	rounded	yes
	upper molar	irregular perpendicular	rough	yes
	humerus	spiral	rough	no
	radius	spiral	rough	yes
	femur	spiral	rough	yes
indet	indet frag	flaking	rough	yes
	indet long bone	flaking	rounded	yes
large mammal	humerus	spiral	rounded	yes
	radius	spiral	rounded	yes
	femur	spiral	rounded	yes
	indet long bone	spiral	rounded	yes
	indet long bone	spiral	rounded	yes
	indet long bone	spiral	rounded	yes
	indet long bone	spiral	rounded	yes
	indet long bone	spiral	rounded	yes
	indet long bone	spiral	rounded	yes
	indet long bone	spiral	rounded	yes
	indet long bone	smooth perpendicular	rounded	
red deer size	radius	spiral	rounded	no
Stephanorhinus hunsheimensis	ulna	spiral	rough	yes

Table 5.3 Assemblage fracture patterns

5.10 Discussion

The site of Boxgrove is one of the largest and most unique sites in north-west Europe. The extensive excavation of part of this land surface and the tracking of the sediments over 26km on the British south coast provides one of the largest known palaeolandscapes in Britain and northern Europe. Considering the time frame represented at the site (MIS 13/12; c. 500 kyr bp) the preservation of such a large quantity of faunal and lithic material is extraordinary. The majority of the faunal material was recovered from units 4b, 4c and 5a though material has been found throughout the sequence from the marine Slindon Sand deposits and even in the overlying periglacial deposits.

The general weathering of the faunal remains highlights a fairly uniform pattern across the entire assemblage. Most of the material is unweathered or demonstrates minimal weathering, indicating that the material was exposed for a limited period of time prior to burial. The absence of heavily weathered material and limited differential weathering suggests that material has not be reburied or re-exposed (using Behrensmeyer, 1978). A detailed analysis of the context and species weathering patterns shows that there is little or no variation in the weathering pattern that again indicates rapid burial in each context. The gentle depositional conditions highlighted in Unit 4b (intertidal deposits) provided excellent conditions for rapid burial, whilst the absence of other natural modification and the close proximity of refitting lithic and bone specimens indicates that there was a limited amount of pre or post burial disturbance. Interestingly, the soil horizon (Unit 4c) demonstrates similarly rapid deposition even though the environment was fully terrestrial, though it is within the lower horizons (particularly Unit 4b) that more structured hominin behavioural signatures can be identified (see below).

Natural modification has been recorded on the faunal assemblage from most contexts though its distribution and severity on the bones is relatively light. There is some evidence for sub-aerial attrition, related to bone exposure on the surface and some evidence for hydraulic rounding though this is mainly confined to the channel deposits. There is considerable variation in the amount and severity of these types of modification but it does not appear to have affected the preservation of specific skeletal elements through either selective preservation or deletion.

Bone density at a general level shows no discernable pattern of preservation. Many of the medium-sized species, particularly cervids and equid, have an element representation that includes both cranial and post-cranial elements and the portions surviving do not appear to relate to the relative density of those elements. Overall, the assemblage certainly does not demonstrate density mediated destruction though some elements appear to have been removed (see later), though this is related to predator/scavengers and hominin behaviour. The fragmentation and preservation of elements within the overall faunal assemblage appears to suggest the attritional accumulation of material at different points in the Boxgrove palaeolandsurface throughout the duration of its existence. Some of the species appear to represent accumulation through natural deaths, though the fragmentation and representation of some specimens appears to suggest a cultural accumulation closely followed by predator-scavenger modification.

5.10.1 The role of hominins and predator-scavengers

The large quantity of lithic tools recovered from the Boxgrove deposits are testament to the presence of hominin communities in this landscape. The extraordinary preservation conditions of the Boxgrove deposits allow for a particularly detailed analysis of the relationship between predator-scavengers and hominins within the Boxgrove palaeolandscape.

Bone surface modification of the Boxgrove large/medium-sized faunal assemblage is heavy (20%), compared with some of the other sites (see Chapters 6-8). The vast majority of this modification (18%) relates to hominin butchery behaviour with only a small amount identified as predator-scavenger (2%). The bone modification on each species has produced a similar interpretation of hominin/predator-scavenger interaction. The BSM on dominant species (cervids and equid) highlights a comprehensive utilisation of nutrients from both cranial and post-cranial elements with evidence for the disarticulation of long bones from the carcass followed by filleting and finally, deliberate fracturing to extract marrow. Cut marks on the skull indicate skinning and defleshing prior to detachment from the vertebral column, presumably for easier access to the cranial vault. Similar cut marks on the mandible and teeth roots is indicative of disarticulation to allow easier access to the tongue and mandibular meat. The disarticulation of the vertebral column may relate to the transport of these elements offsite, or reflect the consumption of the spinal cord. Cut marked rib epiphyses and shafts represent butchery and disarticulation for access to both meat and internal organs.

This analysis has demonstrated that no animal resource was wasted, with antlers removed presumably for use as soft hammers, whilst the distal epiphysis of a red deer humerus was used as a percussor. The fine-grained nature of the Unit 4b allows for the identification of individual isolated butchery events, such as GTP 17, where a single horse appears to have been acquired, possibly through hunting as indicated by the scapula impact point. The identification and isolation of knapping scatters at GTP 17 highlights that these communities had sufficient time to produce butchery tools and sufficient skill to keep large carnivores, such as lion and hyaena, away from their kills.

Other species highlight different patterns which suggest a more passive strategy, possibly scavenging resources from natural death or previous carnivore kills, a particular example of this is the pattern in the bison. Most modification across bison remains is concentrated on the lower limb bones in the form of cut marks and deliberate fractures suggesting the removal of small meat remnants and the extraction of marrow. As with the red deer skeletal modification, vertebral fragmentation could represent an attempt to exploit the nutrient rich spinal cord. Data from bone surface modifications on Bison remains suggests that resources were limited on these carcasses, which reflects a less active procurement strategy that exploited resources from natural death assemblages.

The presence of both hominin and non-hominin carnivore modification on elements from different species suggests that competition for resources did occur in this palaeoenvironment. The absence of definitive butchery sites in Unit 4c is related to the exposed, grassland environment where low deposition rates, compared with Unit 4b, and the high visibility of carcasses would have resulted in the rapid dispersal and destruction of skeletal elements through natural trampling and off-site removal by hominins and/or carnivores. The majority of carnivore modification where it is found in occurrence with hominin modification overlies it, providing strong support to the idea that these predator-scavenger populations had secondary access to most carcasses. Indeed, even when the indeterminate species are considered the majority of the recorded modification relates to hominin butchery, with a few examples of predator-scavenger tooth pits or scratches. Even on indeterminate specimens hominin modification is rich and varied with all stages of the butchery process including disarticulation, skinning, filleting and deliberate fracturing represented and provides further evidence of hominin primacy at carcasses. The detailed taphonomic analysis presented in this chapter indicates that hominins had primacy of access to most carcasses and resources, which supports previous interpretations of hominin behaviour at Boxgrove (Pope and Roberts, 2005; Roberts and Parfitt, 1999b). The horse scapula impact point is the only direct evidence for carcass procurement method, and this thesis could not identify any clear distinction between hunting or confrontational scavenging as the main mode of procurement.

Boxgrove provides a unique insight into the behaviour of hominin populations and their interactions with other predator and prey species. The fine-grained deposits from the site highlight a relatively warm late interglacial environment with a wide diversity of predator and prey species. The faunal material from the site demonstrates an attritional accumulation of material on this landsurface with rapid burial and limited exposure to sub-aerial weathering and attrition. Previous work with refitting of both lithic and faunal remains highlights that material has moved very small distances from where it was originally deposited (Roberts and Parfitt, 1999a) and represent little or no density mediated destruction, which for the Lower Palaeolithic is exceptional. Although the evidence illustrates that hominins were well established at or near to the top of the food chain, the behaviour preserved also illustrates considerable flexibility in the meat-procurement strategy perhaps demonstrating an excellent understanding of the Boxgrove palaeolandscape and the resources available.

Chapter 6 Lynford analysis and results

6.1 Species specific preservation and modification

The excavations at Lynford yielded a total of 2006 individual finds for the faunal remains and a large NISP (n= 3498) (see Figure 6.1 and; Appendix 3 Table 2). The faunal material demonstrates a wide diversity of macro and micro fauna species (Schreve, 2006, in press). The macro-species highlight a 'cold stage' fauna that is comparable to the so-called 'mammoth steppe fauna' (Guthrie, 1984, 2001).

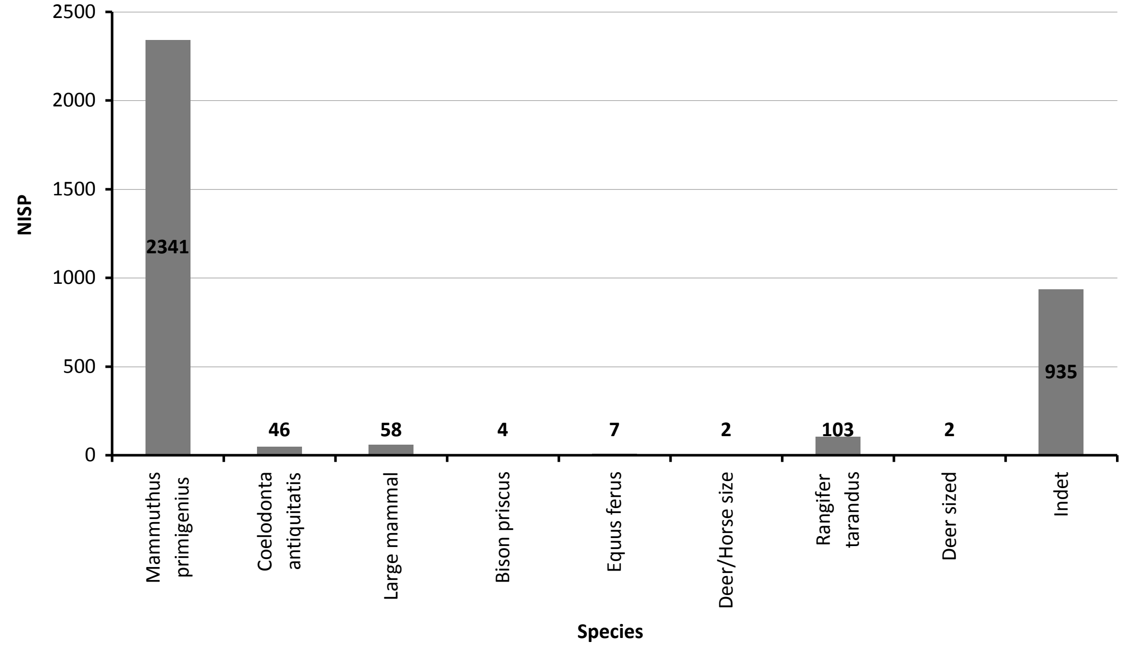

Figure 6.1 NISP counts by species

The faunal assemblage is dominated by mammoth remains (NISP=2341; 66.9%) and other associated cold-stage species such as reindeer (NISP=101; 2.9%); woolly rhinoceros (NISP=46; 1.3%); horse (NISP=7; 0.2%); and bison (NISP=4; 0.1%) (see Appendix 3 Table 2) and closely resembles the Pin Hole Mammal Assemblage Zone (MAZ) identified by Currant and Jacobi (2001).

The artefact and fauna bearing deposits are preserved within an abandoned river channel that resulted from the 'migration' of the river across the floodplain. Analysis by facies demonstrates that the majority of the faunal material was found in Association B-ii (NISP= 3297; 94.3%) with the majority of this material excavated from Association B-ii:03a (89.3%). Smaller quantities of faunal material (NISP= 31) were recovered from Association B-i and B-iii (NISP= 16), which both represent the final stage of channel flow prior to abandonment and the gradual slowing of the river energy regime (see Figure 6.2 and Figure 6.3; Appendix 2 Table 3).

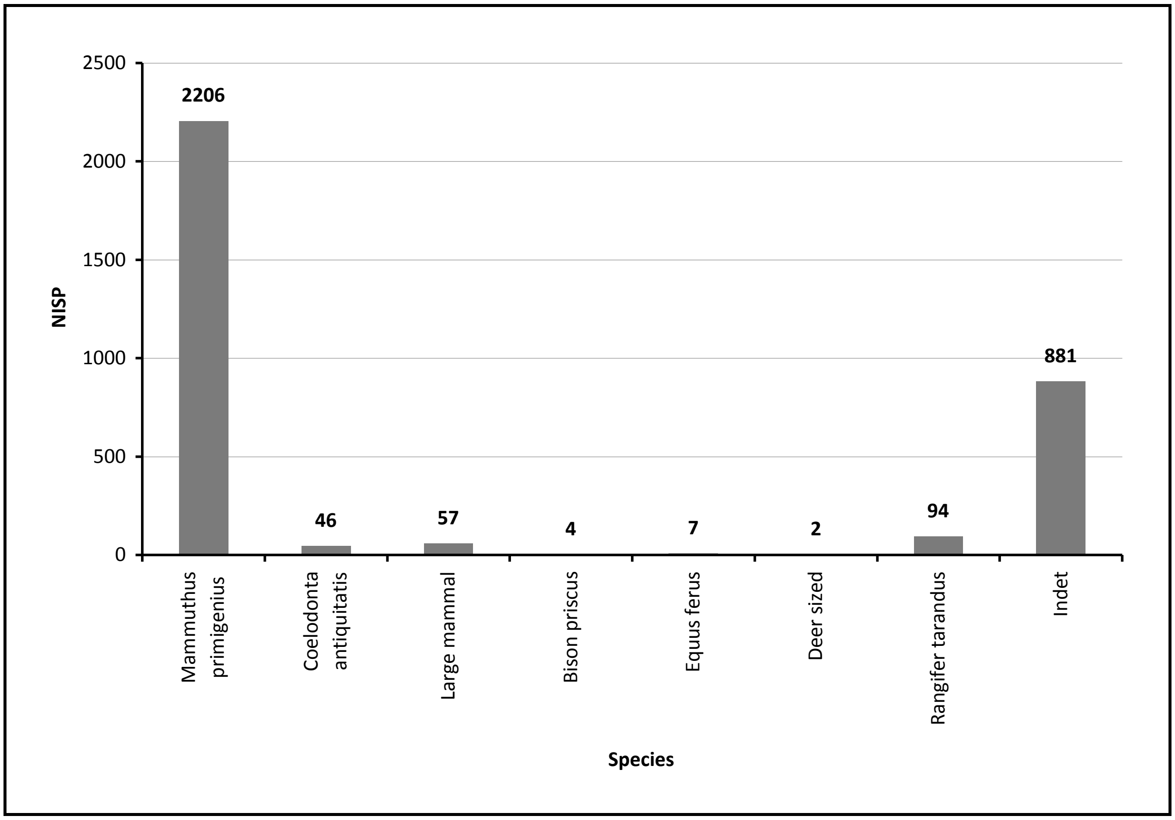

Figure 6.2 Species NISP in Association B-ii

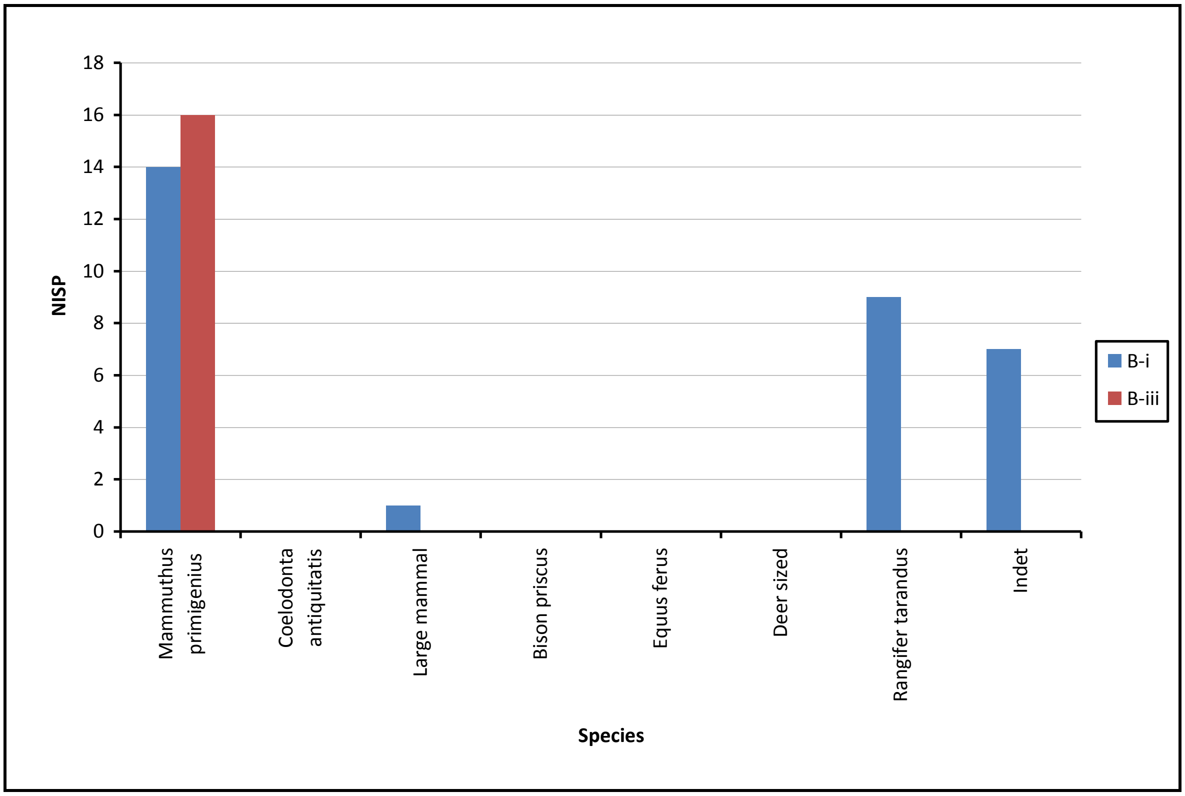

Figure 6.3 Species NISP in Association B-i and B-iii

Given the energy regime responsible for depositing the Lynford sediments and burying the associated lithic and faunal remains, it was deemed necessary undertake an orientation analysis on the faunal assemblage. The analysis assessed the impact of hydraulic action and other sedimentological processes such as mass movement and sediment gravity flow. The rose diagram (see Figure 6.4) highlights a distinct north-south long-axis orientation, which is consistent with the bank slumping events highlighted by Boismier (in press-a; see Chapter 4). There is also a slight north-west to south-east orientation which could also be ascribed to the same physical process (Boismier, in press-a).

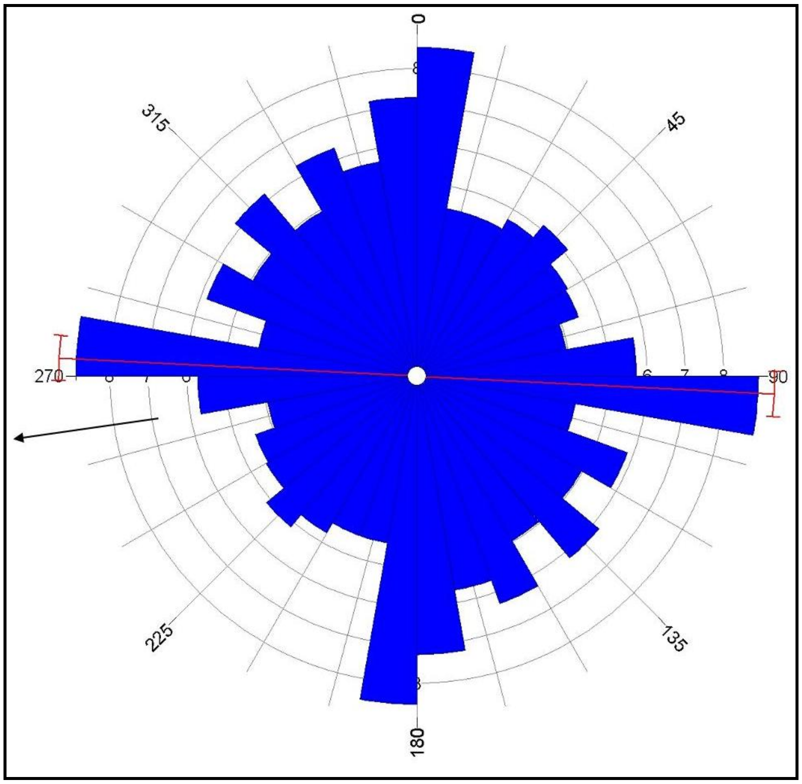

Figure 6.4 Lynford fauna long-axis orientation
Arrow indicates approximate direction of channel flow

Nevertheless, the alignment of some faunal remains approximately west-east, along the route of the palaeo-channel, might indicate the potential for a degree of fluvial accumulation and modification. However, hydraulic rounding (see Section 6.3; Appendix 3 Table 7) on bone fragments is limited in both intensity (1.24%) and distribution (Unit B-ii:02 [20371]; Facies B-ii:03a [20003]), suggesting the reworking of these organic sediments during periods of increased flow, highlighted by the presence of ripple laminae and the input of coarser grained deposits towards the top of the organic sediments (Boismier, in press-a). The presence of hydraulically modified material within the debris flow deposit (B-ii:03c [20131]) may suggest the incorporation of reworked material either during these flow events or as objects derived from the edge of the channel (see Chapter 4).

The long-axis orientation for long bone specimens, which can provide good indication of alignment to channel flow, were also plotted (see Figure 6.5). The rose diagram is dominated by a strong N-S and NW-SE alignment of faunal specimens. Although some material is still orientated in the direction of channel flow, the west-east alignment is less visible, and the long bone orientation appears to correlate with the bank collapse and slumping events (Boismier, in press-a). This orientation suggests that the accumulated material represents, to a degree, the surrounding live animal population, and not the effect of water borne transportation and deposition (Hanson, 1980; Hare, 1980; Isaac, 1983; Stopp, 1997). Limited evidence for hydraulic modification (see Section 6.3) suggests the periodic reworking of material within and alongside the channel during increased flow events, and explains why some specimens were orientated in the direction of channel flow. Faunal density analysis shows the preservation of both high and low density elements rather than a lag deposit composed predominantly of denser elements (see species sections and Smith, 2003a; Stopp, 1997). Bulk samples were sieved through a 500µn mesh (Schreve, in press) and the faunal material recovered included a large quantity of small, lighter specimens that would be easily transported off-site by a faster flowing river (Hanson, 1980).

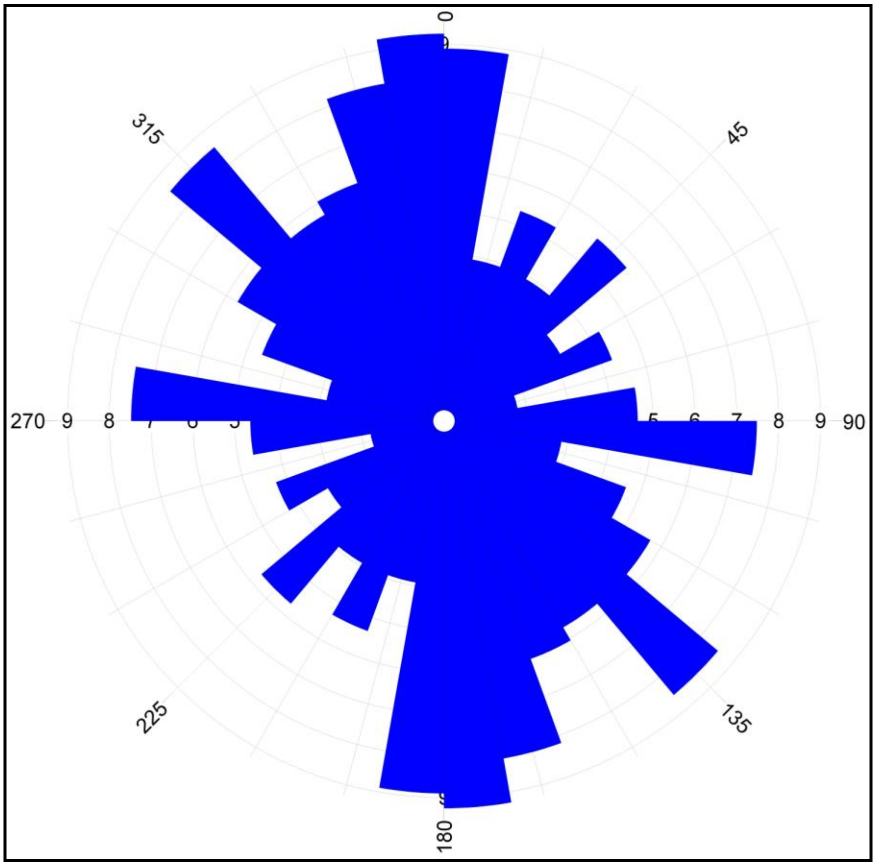

Figure 6.5 Lynford fauna long-bone specimens long-axis orientation

6.2 Weathering

Weathering was recorded across most of the faunal material suggesting prolonged exposure. At a general level the bone weathering highlights an interesting distribution (see Figure 6.6; Appendix 3 Table 4 .

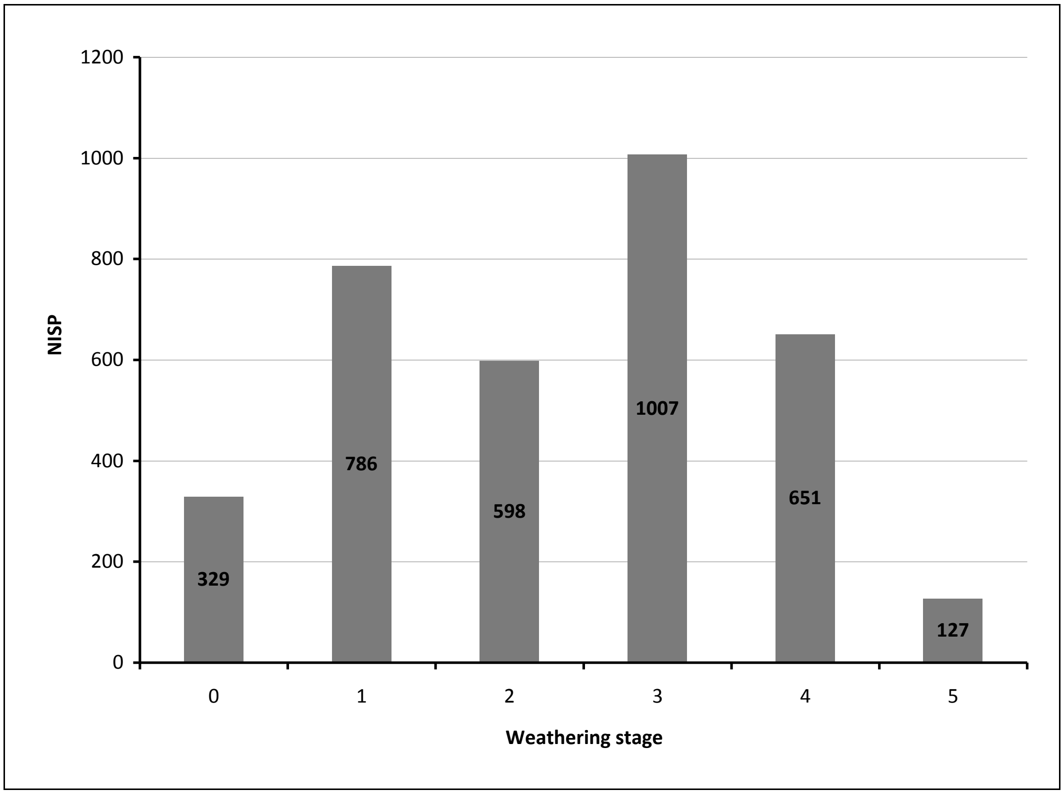

Figure 6.6 General weathering pattern of the Lynford faunal assemblage

The majority of specimens are assigned to weathering stages 1 (22.5%) and 3 (28.8%), with comparatively high figures for stages 0 (9.4%), 2 (17.1%) and 4 (18.6%), and fewest specimens assigned to stage 5 (3.63%). The general pattern highlights differential exposure of the faunal material, suggesting that some specimens were rapidly buried whilst others were exposed for longer time periods possibly signifying the burial and re-exposure of specimens. The average length and width for all specimens in each weathering stage was calculated and appears to illustrate a similarity in the dimensions of specimens from each weathering stage (see Table 6.1). This uniformity in specimen size could relate to the natural modification and constant use of the surrounding environment by different species causing the fragmentation, burial and re-exposure of certain portions (see Section 6.3).

Weathering Stage	Mean Length (mm)	Mean width (mm)
0	58.2	32.1
1	66.3	31.6
2	91.4	38.4
3	86.2	33.2
4	81.2	29.1
5	93.3	36.2

Table 6.1 Average length and width for faunal specimens in different weathering stages

The majority of the faunal material was excavated from Association B-ii (NISP= 3311; 94.3%) and highlights a similar pattern to that discussed above (see Figure 6.6) with high figures for stages 1 and 3, relatively high figures for stages 2 and 4 and lower numbers for stages 0 and 5 (see Appendix 3 Table 5 and see Figure 6.7).

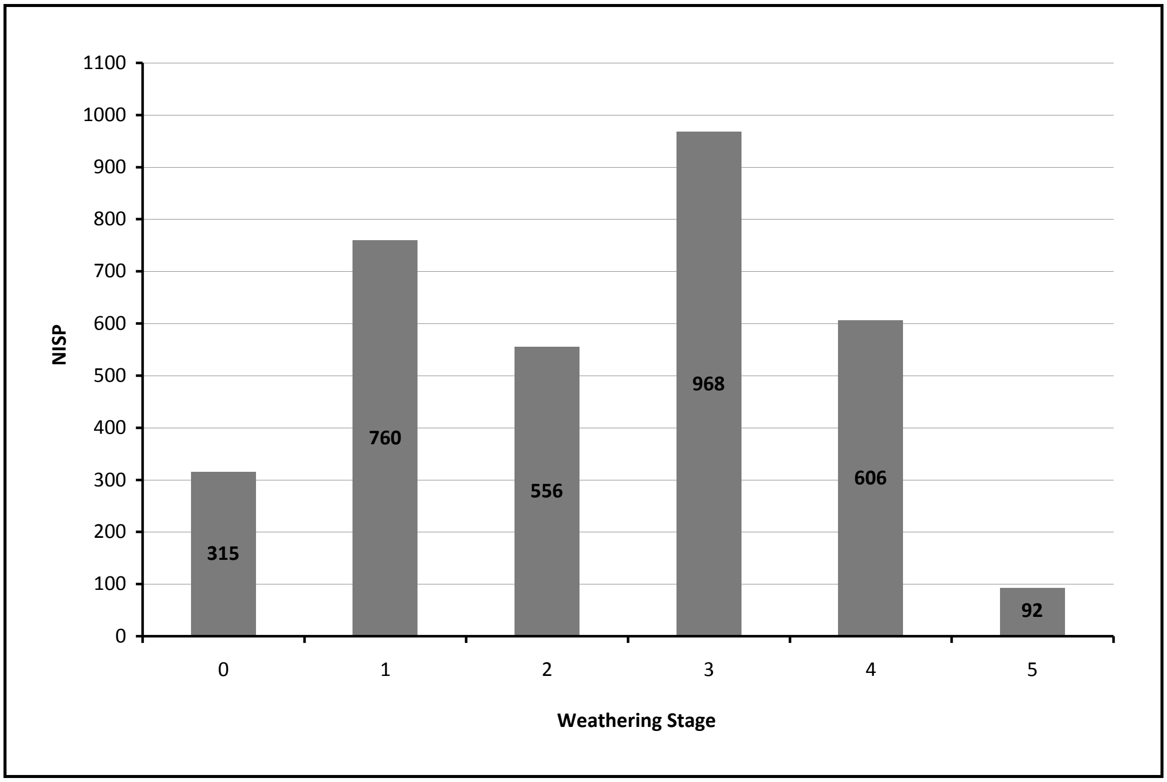

Figure 6.7 Weathering of species in Association B-ii

Breaking this association down further highlights that the fauna is concentrated within two major facies (B-ii:01 and B-ii:03a). Facies B-ii:01 indicates an approximate normal distribution with relatively high numbers for all stages though the majority of specimens fall into stage 3 (see Figure 6.8 and Appendix 3 Table 5).

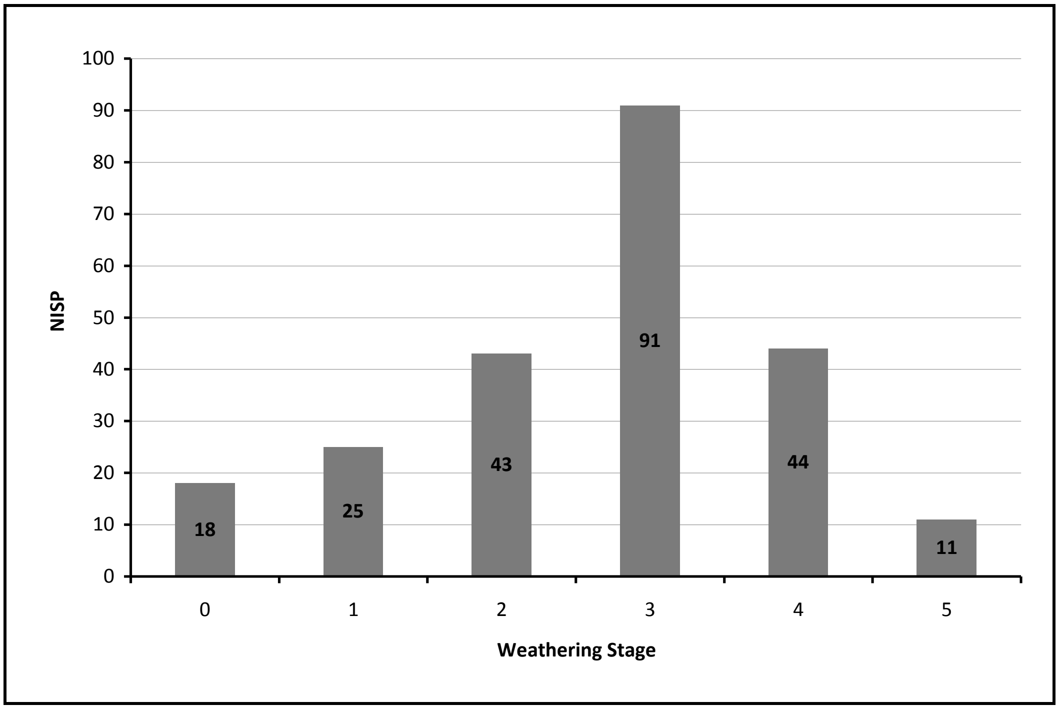

Figure 6.8 Weathering of faunal remains in Facies B-ii:01

Facies B-ii:03a demonstrates the same approximate weathering pattern to that illustrated for Association B-ii (see Figure 6.9 and Appendix 3 Table 5).

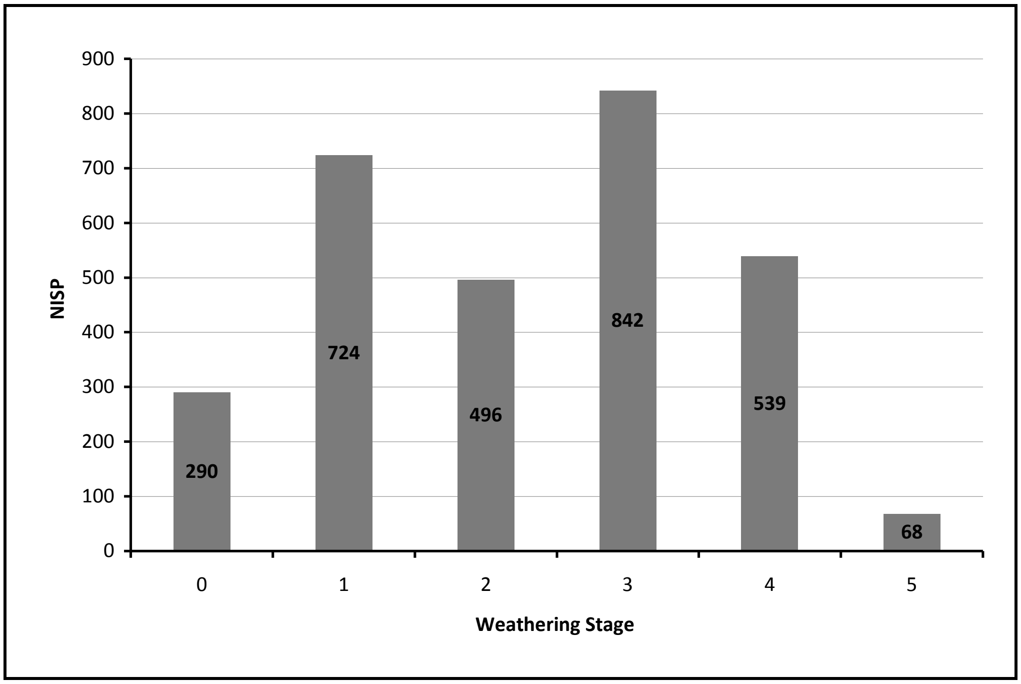

Figure 6.9 Weathering of faunal remains in Facies B-ii:03a

The other facies in Association B-ii contain relatively small numbers of specimens with most concentrated within stages 2-4 and fewer specimens in stages 0, 1 and 5 (see Appendix 3 Table 5). The variation in the weathering of faunal remains throughout Association B-ii suggests that the material was not deposited as a single homogenous assemblage such as a mass death event (Haynes, 1985).

Although the pattern of specimen weathering is less clear for associations B-i and B-iii this may relate to the smaller quantity of material recovered from these horizons (see Appendix 3 Table 5). Although fewer specimens were recovered, a relatively large quantity of material was identified from the heavily weathered categories (stages 4 and 5). Both associations demonstrate variations in the river flow regime, and faunal material could have been incorporated from the channel margins, through bank erosion or overbank flooding, during more active channel flow (see Chapter 4). These specimens may represent the material which was furthest from the channel edge and consequently exposed to terrestrial process longer, explaining the greater proportion of heavily weathered material.

6.2.1 Weathering by species

The weathering of the mammoth fauna in Association B-ii illustrates the same general pattern discussed above (see Appendix 3 Table 6) with high figures for stage 3 (28.3%); similarly for stages 1 (20.9), 2 (18.9%) and 4 (20.8%); and smaller figures for stages 0 (7.05%) and 5 (4.01%). The variation in assemblage condition suggests specimens were exposed to terrestrial weathering for varying time lengths and indicates that the faunal material was not deposited as a single homogenous event but as separate events throughout the existence of the channel environment (see Figure 6.10).

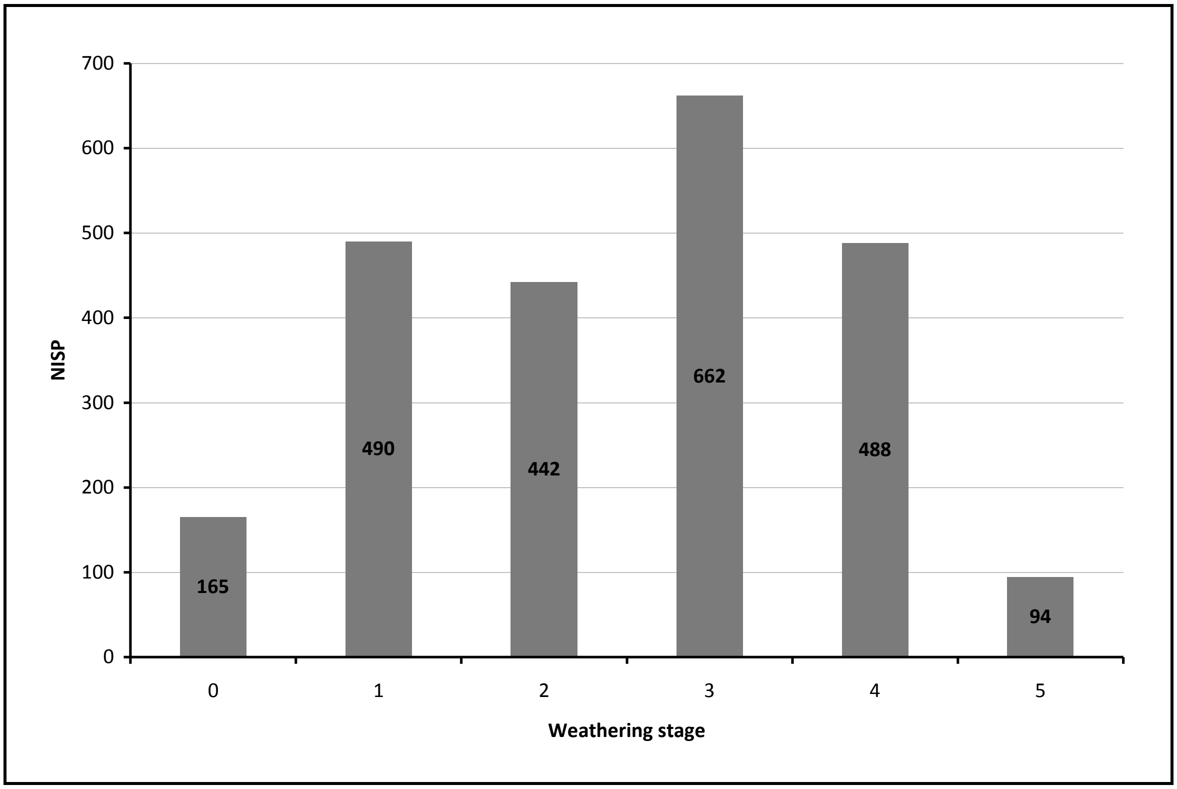

Figure 6.10 Weathering of mammoth fauna at Lynford

Interestingly, the pattern of reindeer weathering within Association B-ii illustrates that the majority of the material (68 %) relates to stages 0, 1, and 2 with fewer specimens in the highly weathered stages (3, 4 and 5) though stage 4 appears to have more specimens than the others (see Appendix 3 Table 6 and Figure 6.11). Such a pattern could indicate exposure for a shorter time period and suggests that these remains entered the site as a more homogenous entity as a result of isolated events possibly relating to predator/scavenger or hominin activity (see Section 6.10.1). Although there is variation in the weathering stages identified for other species, the small number of specimens recorded makes it difficult to assess whether any patterns are real or a function of the total number of faunal specimens (see Appendix 3 Table 6). Nevertheless, the variation in weathering patterns suggests that the material was not accumulated together as a single assemblage but continually accumulated throughout the duration of the oxbow lake environment and supporting the idea that the faunal material has been accumulated over the depositional history of the sediments. The small numbers of individuals indicated could be a function of natural death or represent the activities of predator/scavengers or hominins.

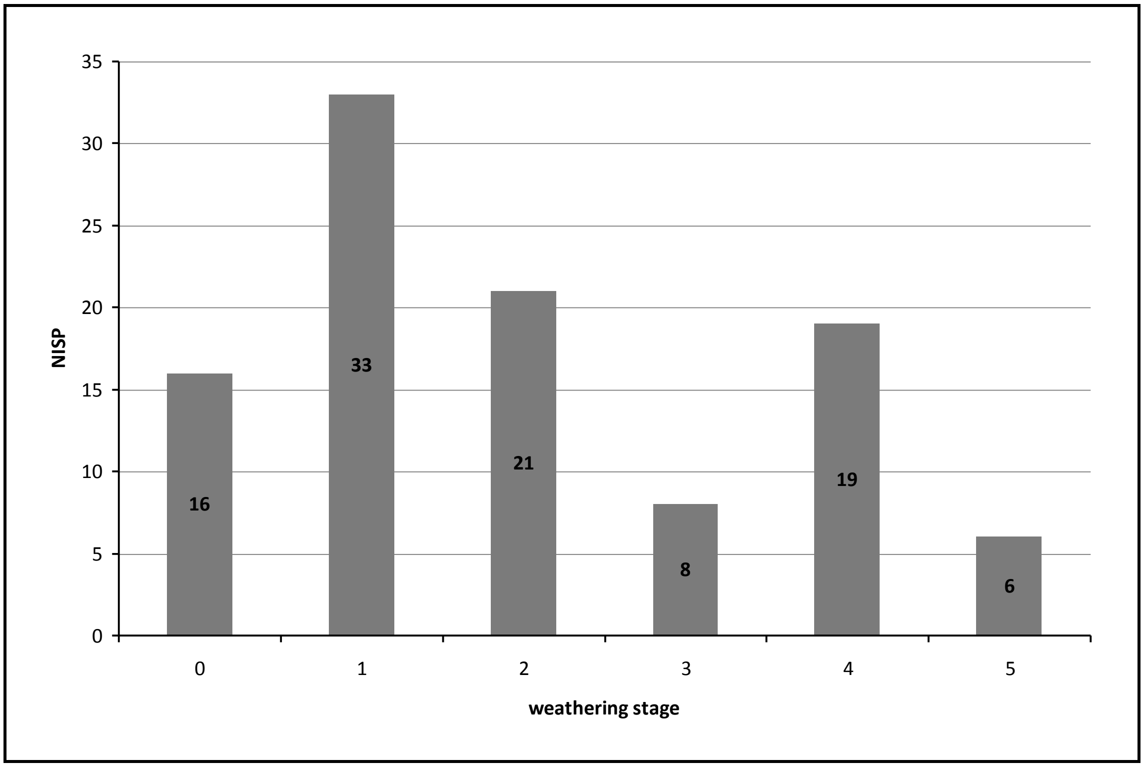

Figure 6.11 weathering of reindeer fauna at Lynford

Although there appears to be considerable variation in the weathering pattern throughout the associations and between species, it appears that the faunal assemblage represents a palimpsest that has accumulated as a result of numerous events (with the exception perhaps of the reindeer remains). Other supporting evidence (see Section 6.3) suggests that material has not moved far post deposition but the faunal assemblage cannot be treated a single event and any discussion of bone collection/modification must consider assemblage formation and modification over a longer time period.

6.3 Other natural modification

The discussion above has suggested that multiple deposition events were likely to be responsible for the formation of the recovered faunal assemblage. The presence of lithic tools on the site indicates a hominin presence, but as a first step it is vital to consider and test for the possibility that the faunal assemblage has accumulated as a result of natural modification agents. Without excluding the role of other natural bone accumulators (e.g. carnivores/rivers) it will be impossible to assess the importance of hominins as faunal accumulation agents at the site.

The majority of natural modification is related to cracking caused through terrestrial weathering (84%), along with evidence for abrasion (pitting 72.4%; scratch marks 14.6%) possibly made both pre and post burial (See Appendix 3 Table 7). The presence of root etching on some specimens (n=32; 1.6%) indicates incorporation into the deposits after near-surface exposure (see Appendix 3 Table 8), with modification ranging from light etching (81.8%) through to heavy etching (18.8%). These are fairly subjective categories but serve to illustrate that whilst some skeletal remains were incorporated into the deposits at depth others may have remained on or near the surface.

Variation in the patterns of weathering and natural modification suggests that faunal material was exposed to terrestrial weathering for different time periods before incorporation into the channel fill deposits. These lines of evidence suggest that the faunal assemblage does not represent a single accumulation event but that numerous events were responsible for the accumulation of material around the margins of the former channel before subsequent slumping of material into the disused channel. The faunal long-axis orientation and the absence of significant quantities of hydraulic modification suggest that the river was not an important agent of accumulation at Lynford. The changes in flow regime appear to have reworked material from various units and facies (see above and Boismier, in press-a).

6.4 Megafauna

6.4.1 Mammoth

Mammoth (*Mammuthus primigenius*) dominates the preserved assemblage (NISP = 2341) with 66.9% of the total NISP, and an abundance of cranial (77%) over postcranial (21%) elements[6], but these equate to a small MNI (based upon the MNE = 3; based on M^1 or M^3)[7] (Appendix 3 Table 9 and 10; Figure 6.12 and Figure 6.13). The preservation of two unfused femur heads indicates at least one juvenile individual. The traditional calculation based on faunal elements highlights a small MNI, though Lister (in press) utilises mammoth dental pairing, eruption and wear to suggest a larger value (MNI = 11), though

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[6] The remaining 2% is composed of indeterminate fragments that can be assigned on size to the species Mammoth but are too small to assign even to a large category like cranial or post-cranial.

[7] Supra-script number represents upper dentition whilst sub-script represents lower dentition

clearly the preserved skeletal remains do not provide evidence for such a large number of individuals (MNI = 1).

Body Part Representation (BPR) is dominated by tusk fragments (54.6%) and indeterminate cranial fragments (35.97%). Poor preservation of other identifiable cranial fragments (cranial= 1.5%; Mandible= 0.7%; Maxilla= 0.2%) reflects assemblage fragmentation, though teeth are well preserved (7%) probably due to their high mineral density. The average length for indeterminate cranial fragments is small (59.3mm), compared with identifiable fragments (143.8mm), and the large quantity of indeterminate cranial material (NISP= 641) suggests that skulls have been preserved but in a highly fragmented form.

NISP values for tusk fragments are artificially high due to excellent preservation and improved excavation and recovery methods (NISP= 974). Analysis of site plans highlights that some fragments can be assigned to specific 'tusk clusters', which appear to represent severely degraded tusk that could not be preserved *in situ* (e.g. LYN 51668 &51669). However, some tusks were excavated in a relatively complete condition such as LYN 51817 and 51950 (Figure 6.15). The differential preservation of tusk fragments could reflect either natural degradation or trampling by other animals (including mammoths) around the lake edge, both prior to and during burial (Haynes, 1991).

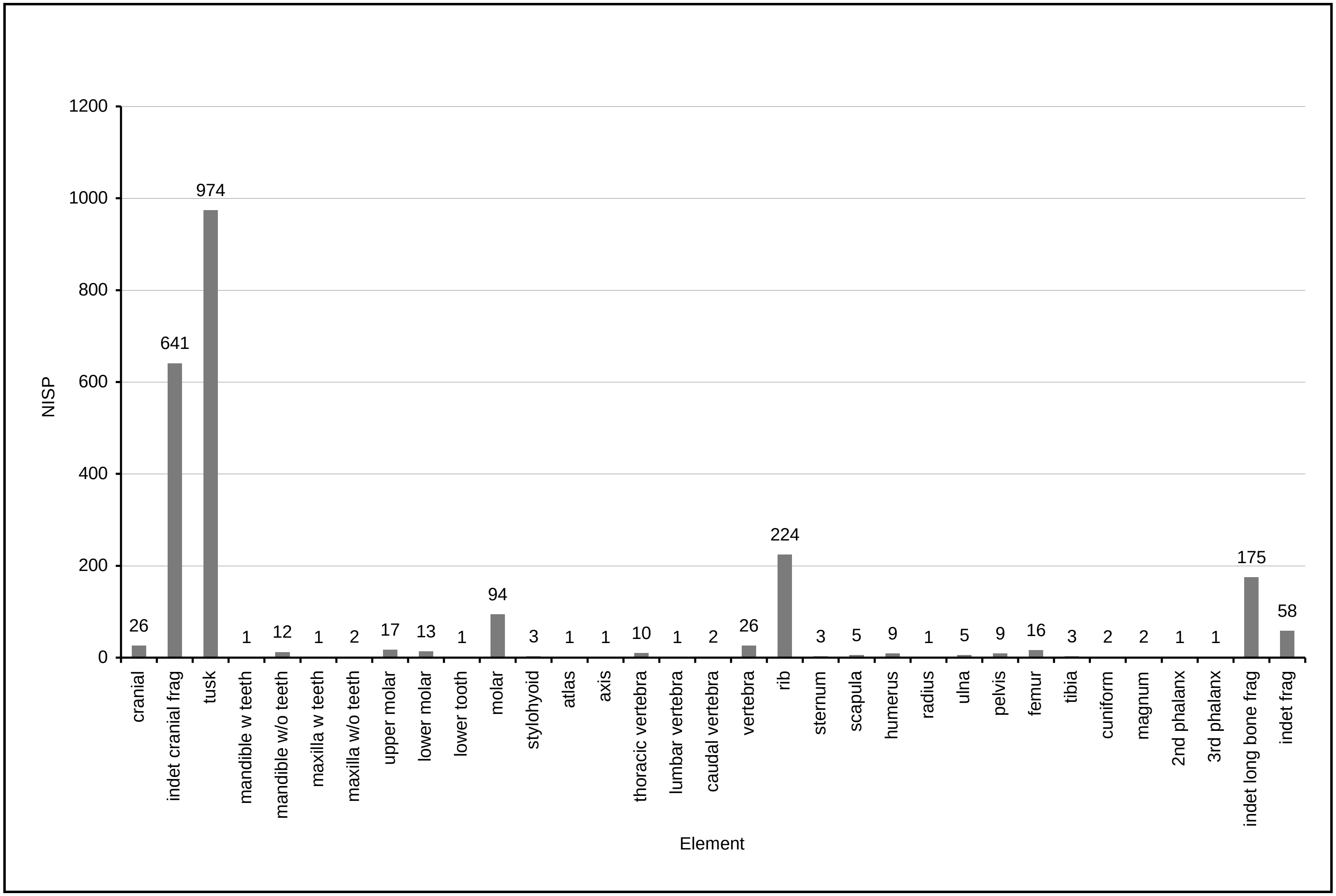

Figure 6.12 Mammoth body part representation

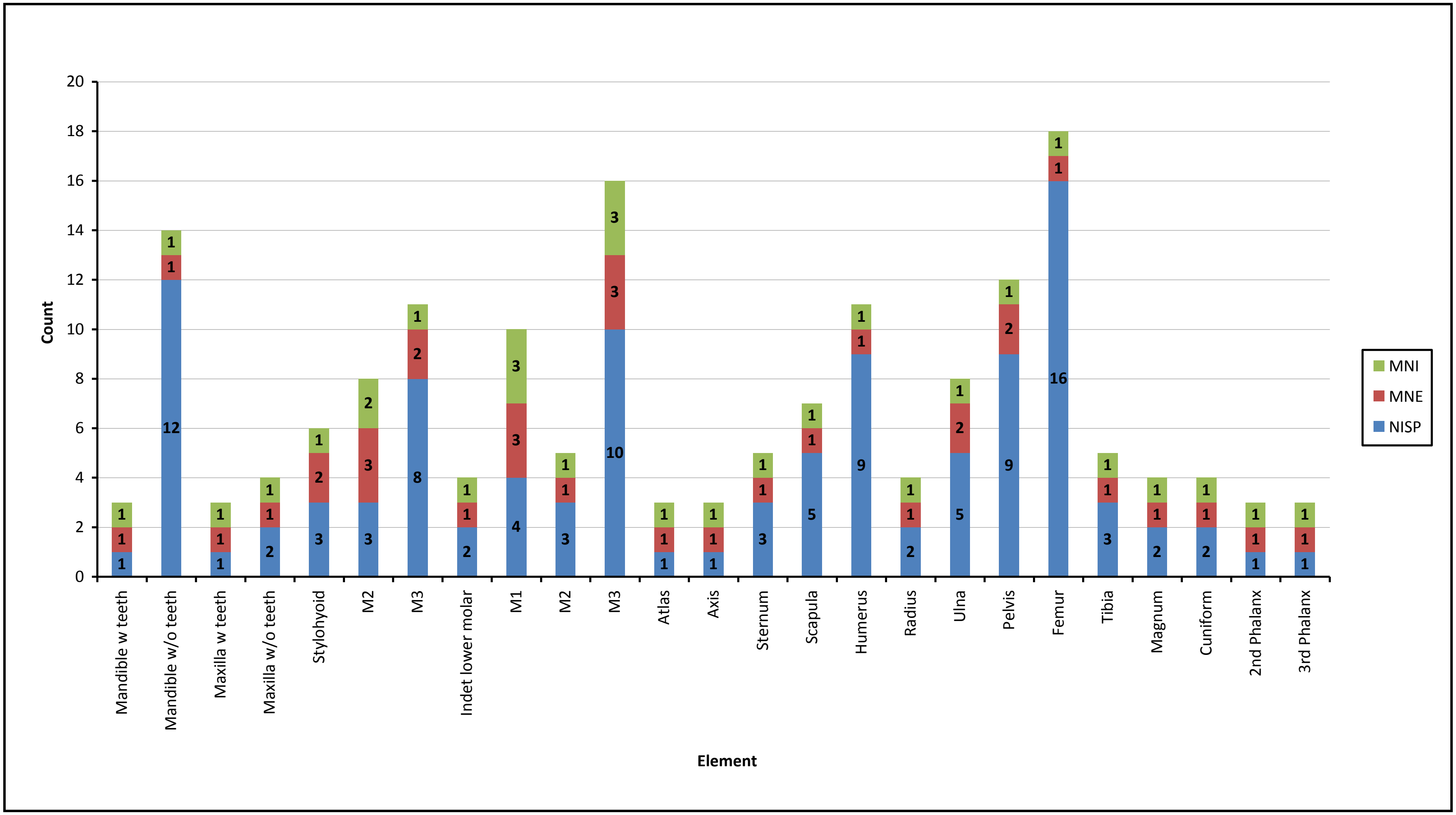

Figure 6.13 Mammoth NISP, MNE and MNI values

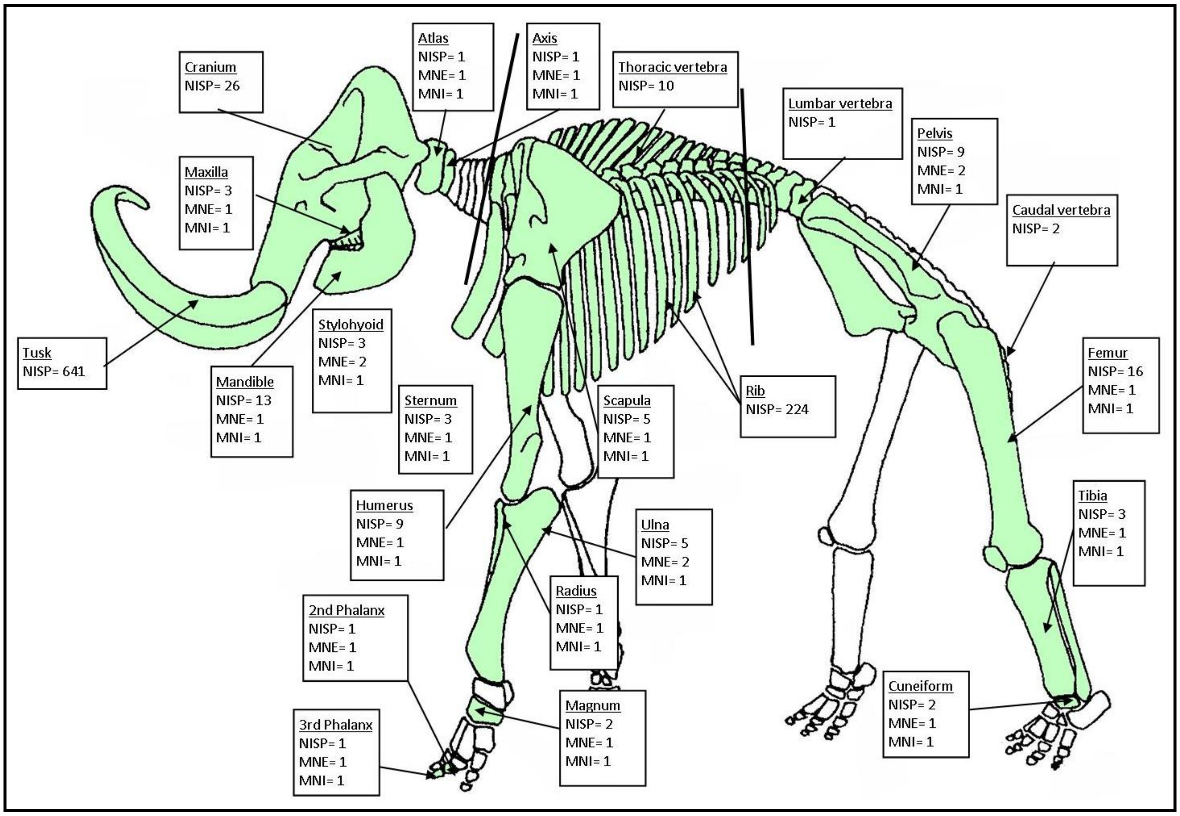

Figure 6.14 Mammoth skeletal representation with NISP, MNE and MNI values
Modified from Williams (2003, Figure 6.2)

A wide variety of mammoth postcranial specimens are preserved from both the axial and appendicular skeleton, though these elements do not correspond with the high MNI suggested by Lister. Scapula and pelvis bone portions are preserved, although these remains appear to be highly fragmented (scapula: NISP=5; MNI= 1; pelvis: NISP= 9; MNI= 1). Preservation does not suggest density mediated destruction, as there appears an equal representation of both dense and less dense portions, which is perhaps due to the small size of the preserved specimens for these elements.

Figure 6.15 Example of a relatively complete mammoth tusk (LYN 51950)
Specimen 1.5m in length

Similarly, long bones are relatively fragmented and do not represent the large numbers of individuals indicated by the dental pairing. The upper long bones (humerus NISP= 9; femur NISP= 16) are better preserved but highly fragmented (humerus MNE= 1; femur MNE= 1). The lower regions are more poorly preserved (radius NISP= 3; ulna NISP= 5; tibia NISP= 3) but exhibit less fragmentation (radius MNE= 1; ulna MNE= 2; tibia MNE= 1), though again conclusions are constrained by the small sample size. The portions preserved for some of these long bone elements appears to be related to the specific density as highlighted by Stopp (1997) (see Chapter 3).

The femoral mid shaft and distal shaft are well preserved (mid shaft= 71.4%; distal shaft= 71.4%), whilst proximal regions are more poorly represented (proximal epiphysis= 28.6%; proximal shaft= 42.9%). This pattern correlates well with the bone surface modification data (see below), which highlights predator-scavenger modification around proximal epiphyses. Remaining long bones do not exhibit such a distinct pattern, though this could relate to the small sample size (see Appendix 3 Table 11). Humeral portions are only represented by shaft fragments (proximal shaft= 33.3%; mid shaft= 33.3%; distal shaft= 66.6%), but again the small assemblage size means the figures are perhaps less significant. Similarly, for the radius, the preservation of a single fragment of distal shaft and epiphysis is insufficient to discuss density mediated destruction or preservation. Tibiae are represented by two fragments of indeterminate shaft and a relatively complete specimen, only lacking the proximal epiphysis. Interestingly, the ulna is represented only by the proximal and mid shaft portions, which Stopp (1997) identifies as having a strong and dense joint with the distal humerus, thus offering a potential explanation for the survival of this region. The preservation of two complete phalanges (2nd and 3rd) demonstrates the durability and density of these regions. There appears to have been some degree of fragmentation throughout the Lynford mammoth assemblage though whether this is directly related to specific bone density is uncertain. Although complete long bones are apparently absent from the preserved mammoth faunal assemblage it is possible that the figures have been artificially deflated, perhaps by assemblage fragmentation. The recovery of large quantities of indeterminate long bone fragments (and indeterminate fragments, see Section 6.8 and Fig 6.12), particularly the denser shaft fragments (NISP= 175), indicates heavy fragmentation and possible destruction of the less dense skeletal regions. The average length of identifiable (humerus = 306.7mm; femur = 328.6mm; radius = 166mm; ulna = 495mm; tibia = 443.3mm) and unidentifiable specimens (average length= 89.4mm) indicates a significant disparity in size. Therefore, it is possible that these smaller, indeterminate fragments may represent fragmented long bones that cannot be refitted. The long bones are present, but have been highly fragmented, as Turner (1989) argued for the faunal assemblage at Klasies River Mouth.

In contrast to the other species, mammoth vertebrae appear particularly well preserved (8.8%), with numerous complete or re-fitting examples (NISP= 39). This is in contrast to other populations, such as reindeer, where the preserved vertebral portions are the denser regions (i.e. the centrum) and there is an absence of the transverse and spinous processes (Appendix 3 Table 12). For the mammoths, vertebral bone density may be significantly greater and capable of withstanding destructive agents. Mammoth rib fragments display a similar pattern of bone survival with numerous complete and conjoining fragments of both epiphyseal and shaft fragments (proximal epiphysis NISP= 51; midshaft NISP= 49; distal epiphysis NISP= 39) (see Appendix 3 Table 13). Normally ribs are more susceptible to destruction, which is possibly why few specimens have been preserved from the other species at the site. The recovery of a larger quantity of mammoth rib specimens may again relate to the greater relative density of these skeletal elements, and the large quantity of indeterminate rib shaft fragments could indicate on site fragmentation of these elements.

The mammoth skeletal representation demonstrates some degree of fragmentation, and the preserved elements do not represent the large number of individuals indicated by Lister (in press). Most of the identifiable remains are fused, which indicates adult individuals, though the presence of unfused femur heads and vertebrae indicate the preservation of some juvenile individuals, further supported by the preservation of deciduous dentition. The comparison of NISPs with MNEs highlights that the longbones have undergone some degree of fragmentation, though the numbers of whole or re-fitting examples are so small their significance is dubious. The large quantities of indeterminate long bone and cranial fragments could explain the absence of whole or re-fitting examples. Indeed, the observed 'absence' may not be real but reflect the fragmentation of these bones on-site through various taphonomic processes, effectively masking the identification of these skeletal portions (Turner, 1989).

Predator-scavenger modification

Mammoth remains demonstrate significant predator-scavenger modification across the entire skeleton on both cranial and postcranial specimen (2.7% of total mammoth specimens) (see Appendix 3 Table 14 and Figure 6.16). Predator-scavenger modification on long bones includes, crenelation around the epiphyses, and along the edges of fractured specimens to access to the longbone marrow from the shaft. Long bone proximal epiphyses are generally the portion with lowest mineral density and predator-scavengers target this region to gain access to the marrow cavity. This can clearly be observed on one femoral specimen where the head has been completely removed by gnawing around the circumference (see Figure 6.17). This phenomenon was highlighted by Binford (1981) as evidence for the removal of the neck to access bone nutrients.

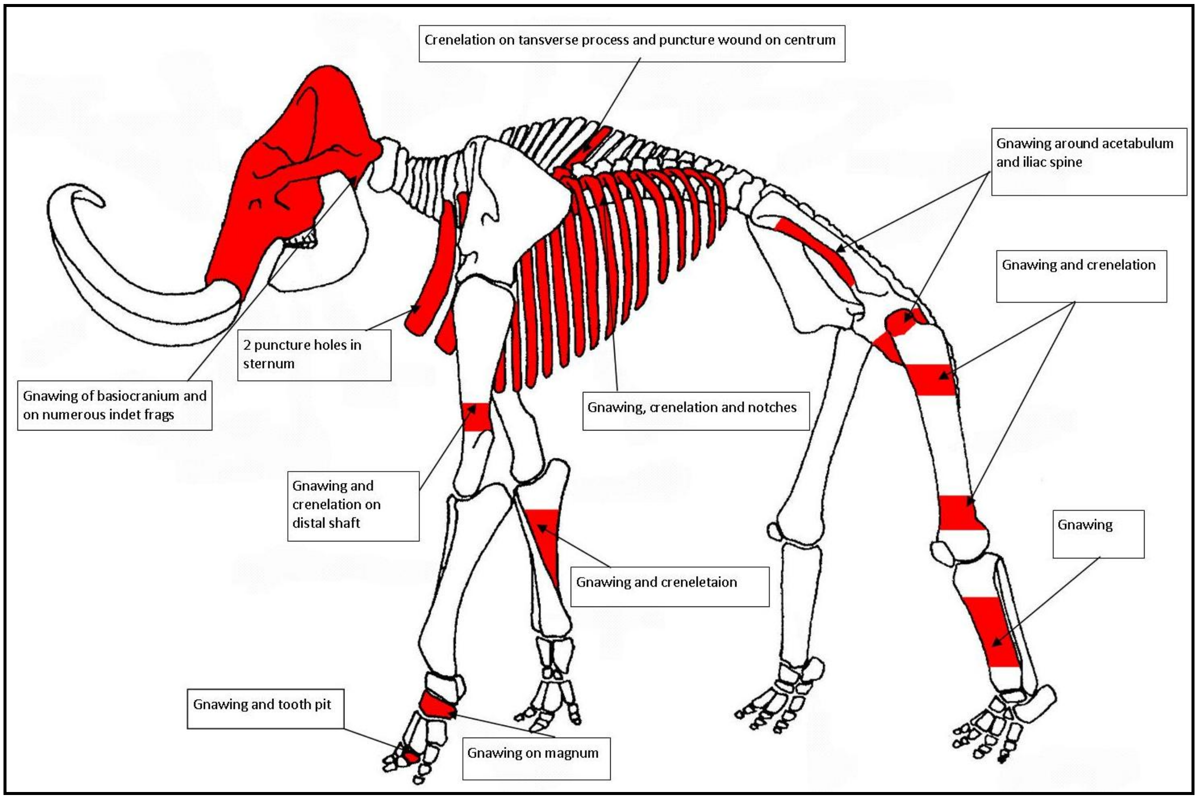

Figure 6.16 Distribution of predator-scavenger modification across mammoth skeleton Modified from Williams (2003, Figure 6.2)

Figure 6.17 Mammoth femur (LYN 50749) demonstrating crenelation around proximal epiphysis and on shaft

Another femur specimen preserves evidence for gnawing around the proximal and distal epiphyses, again presumably to access the marrow cavity (see Figure 6.18). Extensive gnawing on these elements suggests that most of the meat from this region had either been consumed or decayed and the only nutrient that remained was the bone marrow.

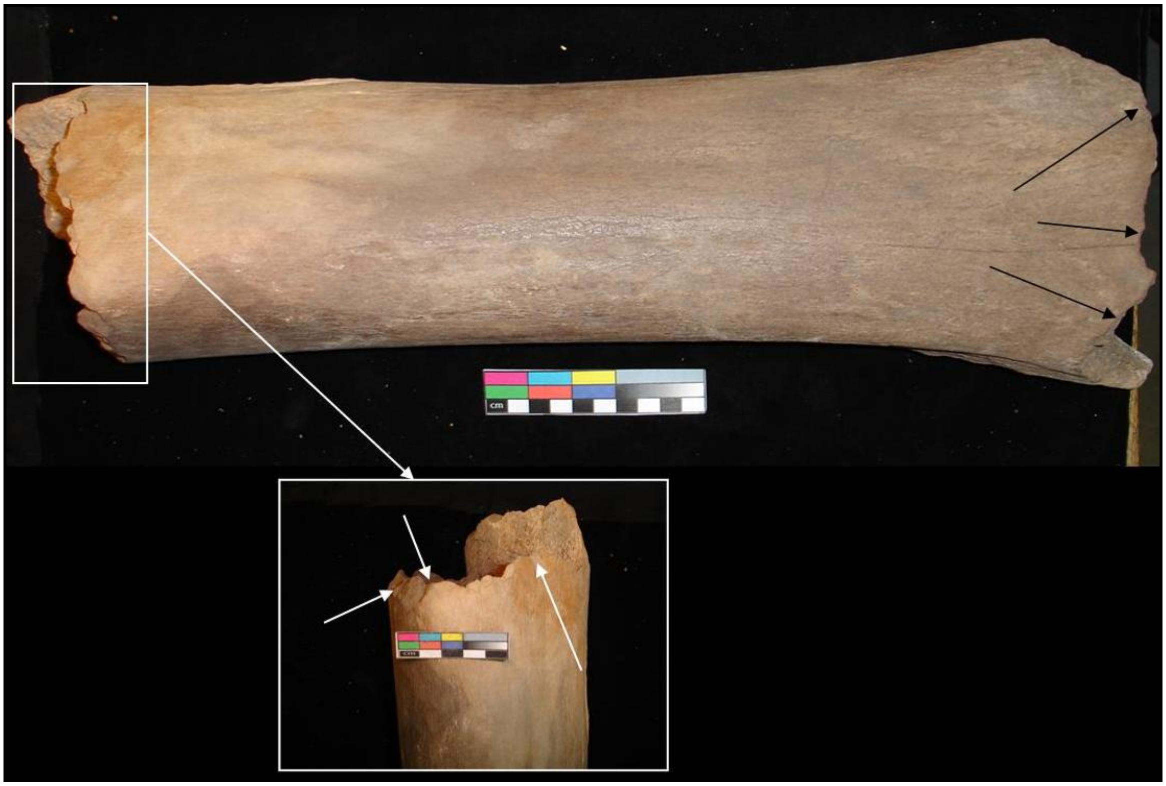

Figure 6.18 Predator-scavenger crenelation around mammoth femur proximal and distal epiphysis (LYN 51575)
Insert provides detail of crenelation around proximal epiphysis

Correspondingly, modification around the tibia proximal epiphysis may represent wolf activity, whilst modification along the mid shaft fragments may represent hyaena modification. This analysis meshes well with the pattern highlighted by Haynes (1980) during his work on archaeological assemblages from North America. Although he does not detail extensive tibia shaft modification in these assemblages, this may represent an absence of scavenging carnivores with strong masticator abilities like hyaena. The predator-scavenger modification suggests that these species were not actively hunting these animals but were exploiting resources from carcasses that had accumulated at this location as a result of the natural deaths of these animals.

Sustained carnivore modification on the humerus is evident from the preservation of a tooth pit on the distal epiphysis, along with gnawing and crenelation around the distal shaft to exploit the bone marrow (see Figure 6.19).

Figure 6.19 Mammoth humerus (LYN 50004) exhibiting carnivore crenelation

Although Haynes (1980) does not document evidence for carnivore modification on the denser distal epiphyses, this probably reflects his work with wolf packs. The single 2nd phalanx recovered preserves evidence for gnawing around the distal epiphyses and sustained chewing, as indicated by the presence of a tooth pit on this specimen (see Figure 6.20). The location of such gnawing modification suggests disarticulation of mammoth remains by carnivores to provide easier access and exploitation of the marrow from long bones such as the tibia, humerus and metapodials.

Figure 6.20 Mammoth 2nd phalanx (LYN 50733) exhibiting tooth pit and gnawing

Interestingly, the rib cage preserves most evidence for predator-scavenger modification. In general the proximal epiphysis displays evidence of tooth marks and crenelation, probably related to the disarticulation of the rib cage from the vertebral column. However, rib shafts preserve most modification ranging from tooth marks to crenelation along the rib edges (see Figure 6.21 and Figure 6.22).

Figure 6.21 Predator-scavenger crenelation on mammoth rib proximal and distal epiphysis (LYN 50977)

Figure 6.22 Predator-scavenger crenelation and tooth pits on mammoth rib head

The presence of crenelation on and around the articulation of the rib and vertebra column indicates disarticulation and exploitation of meat. The thin strips of meat between the ribs are often preserved due to drying on exposure, and the temperature ranges identified through other palaeoenvironmental proxies would have been sufficient to allow such small quantities of meat to survive for longer. Binford (1981) noted, in his work on caribou kill sites in the Arctic, that notches on rib edges often relate to disarticulation when carnivores (particularly wolves) insert their canines between the ribs and pull to both disarticulate and exploit remaining portions of meat between the rib cage. Although such ethnographic patterns may not be directly comparable they potentially offer an insight into predator-scavenger carcass modification.

More relevant data comes from Haynes' (1980) research, which documented gnawing damage on mammoth remains from North American archaeological collections and displays similar characteristics to the damage on the Lynford fauna. Such modification consists of broken transverse and lateral vertebral processes, along with puncture wounds on the centrum (see Figure 6.23).

Figure 6.23 Predator-scavenger tooth puncture on mammoth vertebra centrum (LYN 51377)

Predator-scavenger modification on the pelvis consists of extensive gnawing around the acetabulum probably related to the disarticulation of the femur from the pelvic girdle. Crenelation along the iliac spine is evidence for disarticulation and meat consumption by non-hominin carnivores (see Figure 6.24), and such modification were recorded on faunal remains from ethnographic studies (see particularly Binford, 1981). The pattern of modification suggests that some mammoth carcasses were relatively articulated and that predator-scavengers had early access to remaining tissues, prior to any hominin use. The presence of tooth pits on elements such as the magnum, sternum and vertebra indicate disarticulation and suggests that tissue may have remained on some carcass regions. The evidence for predator-scavenger modification across the entire skeleton indicates that they (wolf and hyaena) were capable of dismembering mammoth sized prey.

Figure 6.24 Mammoth pelvis (LYN 51733) highlighting extensive predator-scavenger modification 1) crenelation along iliac spine 2) crenelation and removal of acetabulum

Tooth pitting and crenelation on indeterminate cranial fragments probably represents the ingestion of skull fragments by carnivores, as highlighted by Binford (1981), an hypothesis which is also supported by the recovery of coprolite material on site. Crenelation on a basiocranial fragment shows gnawing around the base of the skull, possibly leading to the consumption of the brain. However, the skull would have to have been cracked open prior to this gnawing as none of the predator-scavengers present on site have the mechanical abilities to crack open a mammoth skull. Predator-scavenger modification is documented across both cranial and postcranial skeleton, with evidence of disarticulation and primary access to meat and marrow on some mammoth carcasses. There is no evidence that mammoths were actively hunted by non-hominin predators, and the evidence suggests carnivores were scavenging resources from mammoth carcasses that had accumulated as a result of natural death.

Hominin modification

The fragmentary crania may have been deliberately smashed by hominins to access the brain, though trampling by other animals, including mammoths, could equally have caused a similar pattern (see Haynes, 1991). Despite mammoths dominating the preserved faunal assemblage there is no direct evidence for hominin bone surface modification (cut marks). The evidence for extensive predator-scavenger modification perhaps suggests that the faunal assemblage represents a natural accumulation and subsequently exploited by predator-scavengers. Such an interpretation contradicts previously published interpretations of the site (see Schreve, 2006). Schreve (2006) stated that although there are no cut marks on the mammoth fauna, the absence of long bones indicates the selective removal of these portions off-site by hominin communities. The presence of numerous healed lesions and fractures on the rib cage has been postulated as evidence of trauma caused by failed hominin hunting, though this hypothesis is not easy to validate (Schreve, 2006). Such injuries can as easily be caused naturally through falls, collisions or competitive mating behaviour (see Despard Estes, 1991). The mammoth fauna from Lynford does not exhibit any evidence for a hominin subsistence strategy based on megafaunal exploitation, such as that documented at the sites of La Cotte de St Brelade (250kya bp) (Scott, 1980), and Lehringen, where a wooden spear has been found in between the rib cage of an elephant

(Movius, 1950). The absence of evidence for hominin modification on the mammoth fauna suggests that this assemblage represents the natural accumulation of faunal material as a result of natural deaths that has subsequently been exploited, mainly for marrow, by predator-scavengers such as wolf and hyena.

6.4.2 Woolly Rhinoceros

The woolly rhino (*Coelodonta antiquitatis*) skeletal profile displays a low MNI (MNI=1; based on 1st phalanx) (see Appendix 3 Table 15 and Figure 6.25). Although fewer specimens were recovered, teeth appear well preserved (NISP= 36; 78.2%). This high figure, combined with the poor survival of other elements, from both cranial and postcranial skeleton (NISP humerus= 8; 1st phalanx= 1; pelvis= 1), strongly suggests the destruction of less dense skeletal elements. The surviving postcranial remains are also those portions which are more dense (humerus shaft and distal epiphysis; pelvic acetabulum; phalanx cylinder), and thus provide further support for a pattern of survival related to relative bone density.

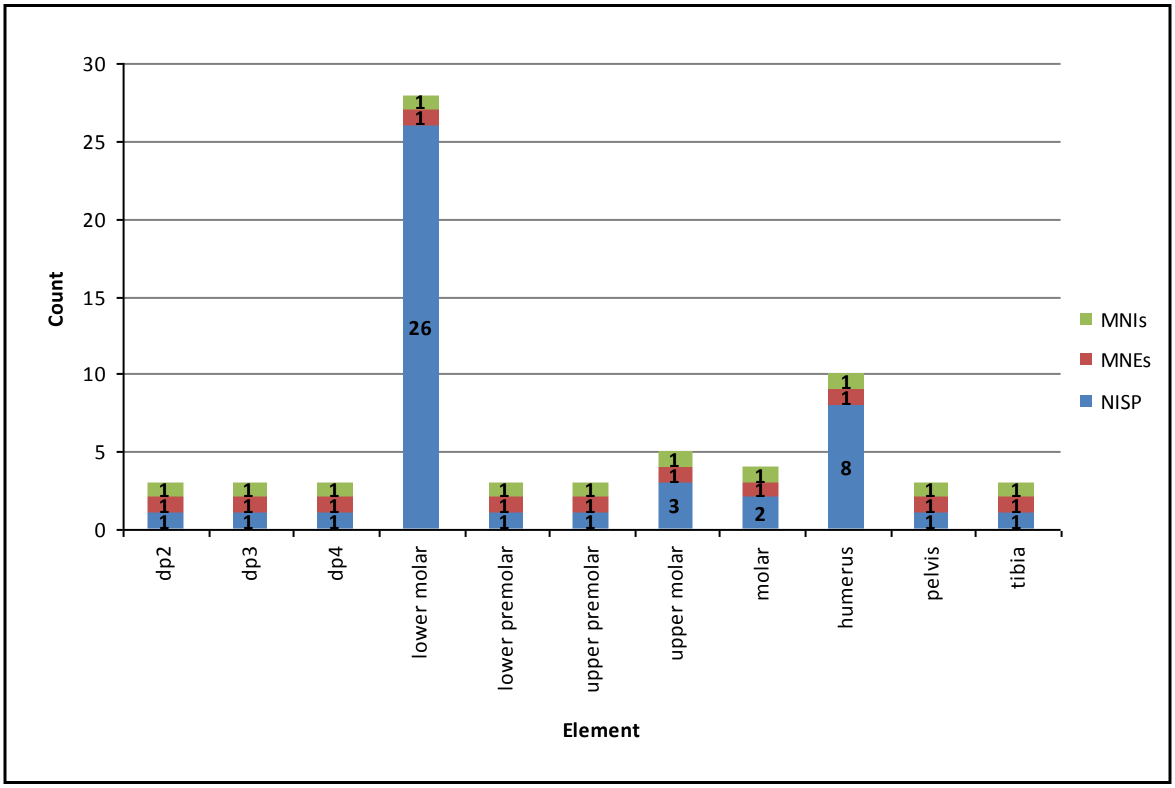

Figure 6.25 Woolly rhino NISP, MNE and MNI values

The survival of deciduous premolars is indicative of the presence of a juvenile individual and could represent either the isolated, natural shedding of dentition at this location or the occurrence of more than one individual. The presence of fused elements and dominance of permanent dentition would appear to indicate at least one older individual in the assemblage. The small assemblage size and limited survival of less dense elements would appear to suggest a natural origin for these faunal remains, though these are cautious conclusions considering the relatively small assemblage size.

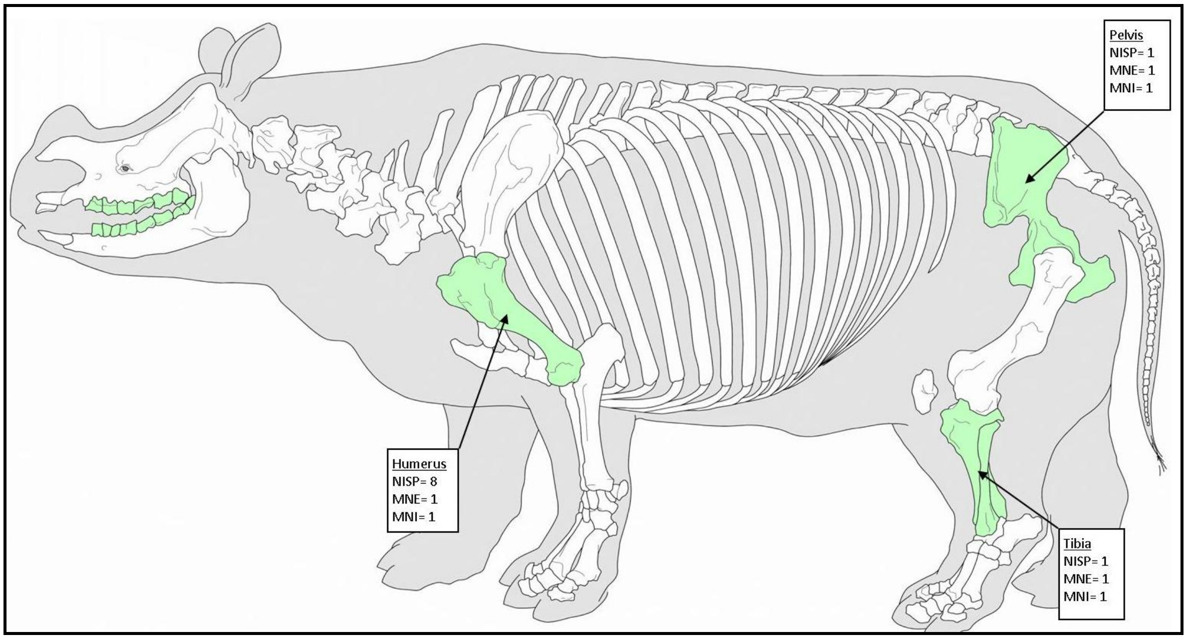

Figure 6.26 Woolly rhino skeletal representation with NISP, MNE and MNI values
Skeletal outline modified from Yvinec *et al* (2007)

Predator-scavenger modification

Predator-scavenger gnawing of a tibia illustrates the ‘classic’ removal of both epiphyses, leaving a cylinder that is indicative of carnivore marrow exploitation (see Figure 6.27, Figure 6.28 and Appendix 3 Table 16). Similarly, crenelation along the iliac spine may indicate the removal of small remnants of meat tissue from this region (see Figure 6.29) (see for example Binford, 1981). The quantities of remaining tissue might have been small and need not necessarily reflect predator-scavenger hunting but the opportunistic exploitation of remaining muscle tissue from this carcass.

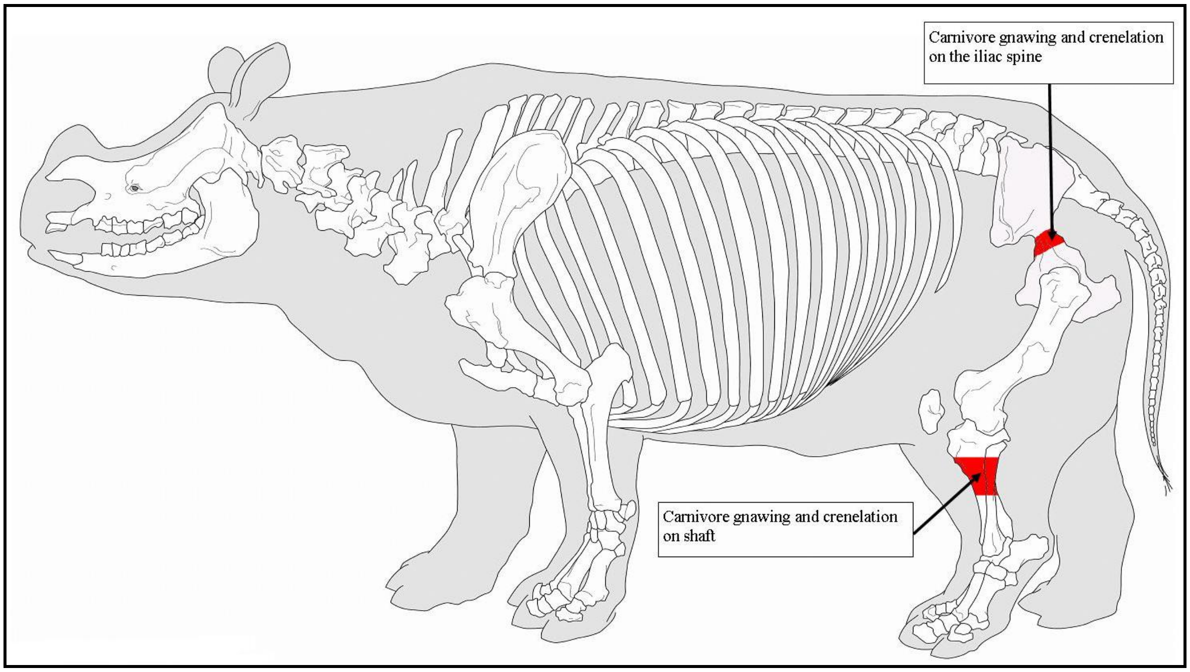

Figure 6.27 Distribution of predator-scavenger modification on woolly rhino skeleton Skeletal outline modified from Yvinec *et al* (2007)

Figure 6.28 Predator-scavenger gnawing and extensive crenelation of tibia shaft fragment (LYN 51374)

Figure 6.29 Woolly rhino pelvis (LYN 51536) with extensive crenelation on the acetabulum and ilium

Hominin modification

Fractured woolly rhino teeth (NISP= 2) indicate the deliberate cracking of mandibles to extract marrow (see Chapter 5) (see Appendix 3 Table 17 and Figure 6.30 and Figure 6.31). It is unknown for teeth to fracture in such an unusual way naturally, so it is entirely possible such modification relates to the cracking of the mandible for marrow extraction. Both the type and limited nature of the hominin modification suggests that there was limited muscle mass remaining, and indicates that these communities were exploiting these carcasses for secondary products such as marrow.

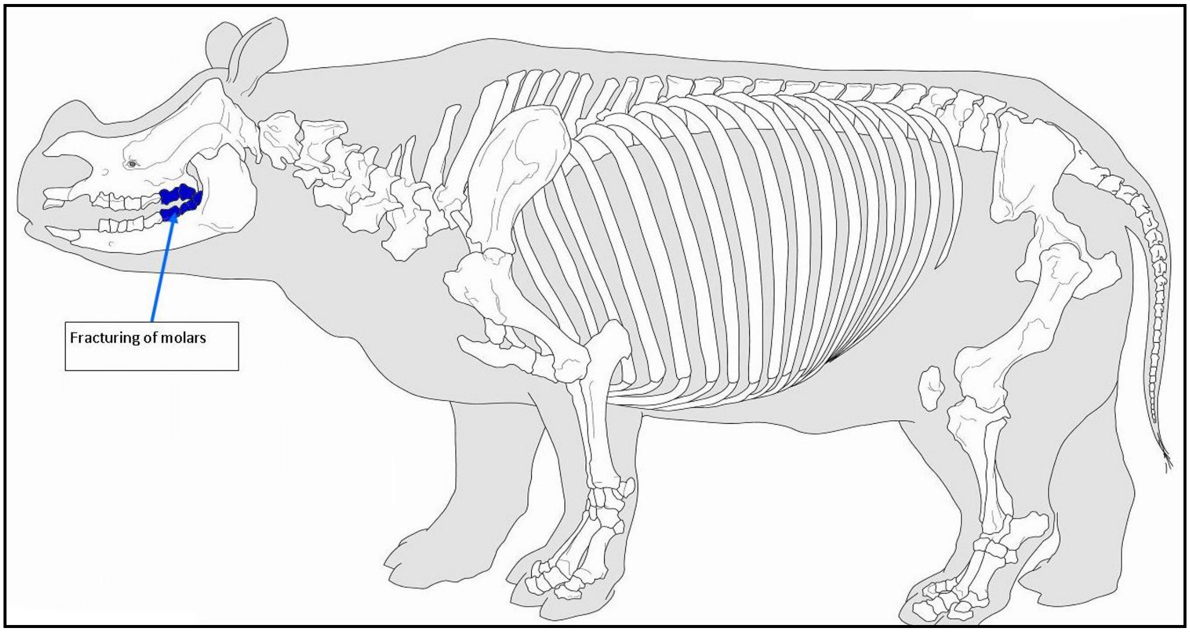

Figure 6.30 Distribution of hominin modification across woolly rhino skeleton Skeletal outline modified from Yvinec *et al* (2007)

Figure 6.31 Woolly rhino tooth (LYN 50559) with hominin deliberate fracture

6.5 Cervid

6.5.1 Reindeer

Reindeer (*Rangifer tarandus*) is a relatively abundant species in the Lynford assemblage (NISP= 103) (see Appendix 3 Table 18 and Figure 6.32). The assemblage is dominated by antler fragments (NISP= 68; 66%), though this is unsurprising as antler is dense and survives well on most sites (Conway *et al.*, 1996). The antlers portions preserved are mainly indeterminate fragments (NISP= 25; 37.3%) but the assemblage also includes tine fragments (NISP= 10; 14.9%); antler bases (NISP= 20; 29.9%); and beam fragments (NISP= 8; 11.9%). Some of the antler bases are shed, indicating a cyclical natural deposition, though the presence of unshed antler suggests that these individuals either died naturally on site or were killed by predator-scavenger or hominin action (see bone surface modification below). Excluding the antler which, like tusk, artificially inflates the NISP counts, the MNI again indicates a relatively low number of individuals (MNI= 2; 2nd phalanx) (see Appendix 3 Table 18 and Figure 6.32). This observation is confirmed when looking at the eruption and wear sequences of the teeth preserved in the assemblage. The preserved M_3 is in wear and could potentially belong to the same individual as the P_4, though both erupt after the dp_2 and so cannot be from the same individual. This produces a low MNI (MNI= 2), similar to that obtained using other skeletal elements.

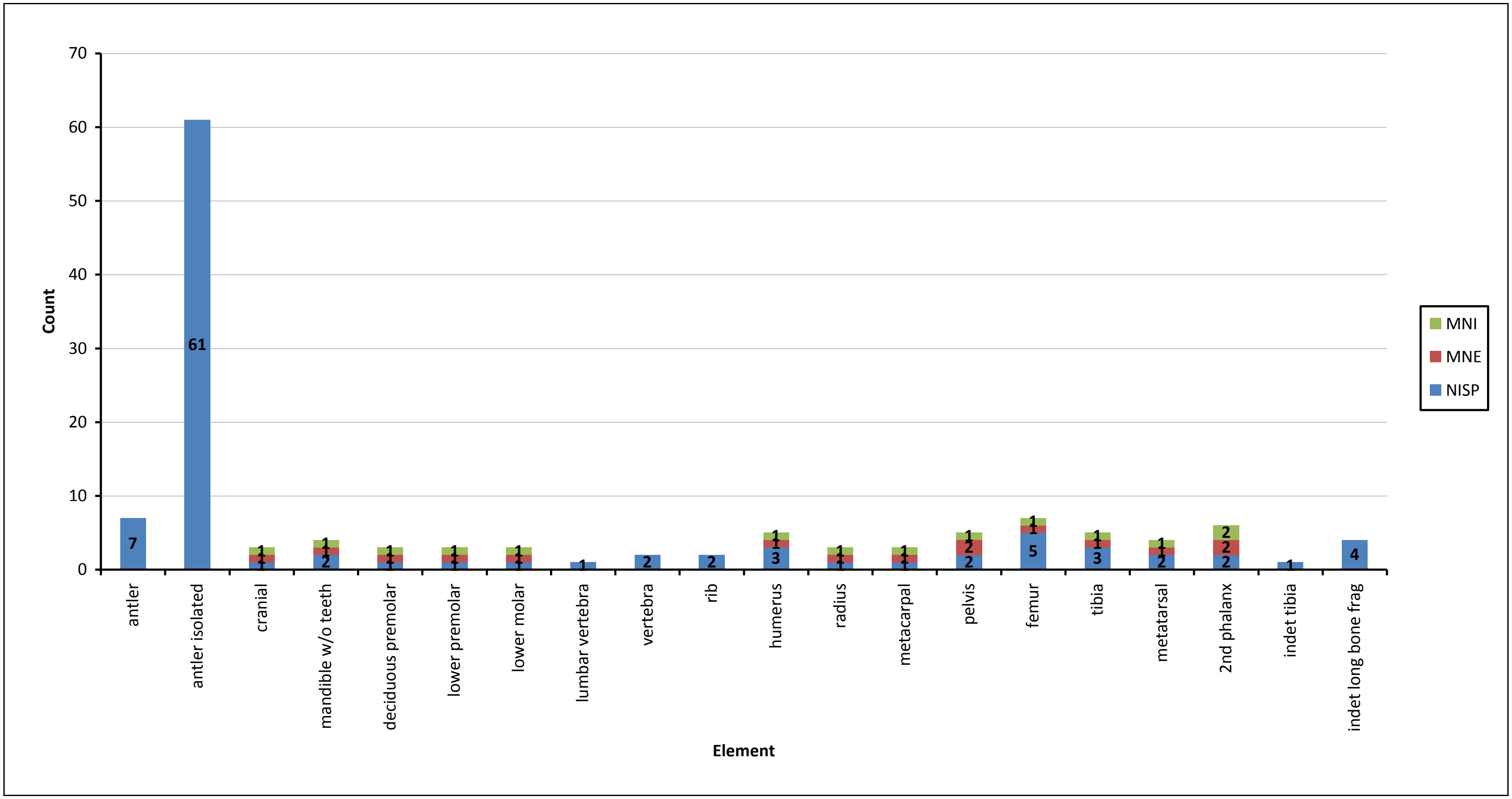

Figure 6.32 Reindeer NISP, MNE and MNI values

Comparing NISP and MNE values demonstrates some long bone fragmentation, though the numbers of fragments identified are low, thus questioning the validity and significance of this pattern. Nonetheless, the portions which survive are those which have been highlighted as denser- shaft, distal epiphyses, proximal radius epiphyses, along with a complete metacarpal and phalanges (Kreutzer, 1992; Stopp, 1997) (see Appendix 3 Table 19). It would appear that relative bone density has influenced the survival of some bone portions, though the size of assemblage raises questions of whether the sample is significant or representative. The surviving bone fragments highlight a predominance of appendicular elements and an apparent absence of axial and cranial elements (Appendix 3 Table 18). This could easily be explained as the differential destruction of these less dense elements by various taphonomic processes. The relatively high counts for humerus, femur and tibia represent the survival of the dense shaft and mid-shaft portions, though the small sample size does not allow consideration of preferential preservation or deletion of specific elements. Therefore, it is difficult to assess whether the absence of vertebrae reflects the *in situ* destruction of these elements or perhaps their removal from site by either hominins or predator-scavengers. However, the absence of even the denser centrum is curious, although such an ‘absence’ may not represent a true pattern. These elements could be contained within the large quantity of indeterminate fragments which has consequently skewed the skeletal representation. Additional bone surface modification also indicates that both hominin and predator-scavenger populations could plausibly have modified and removed elements from the assemblage and produced the observed pattern (see below).

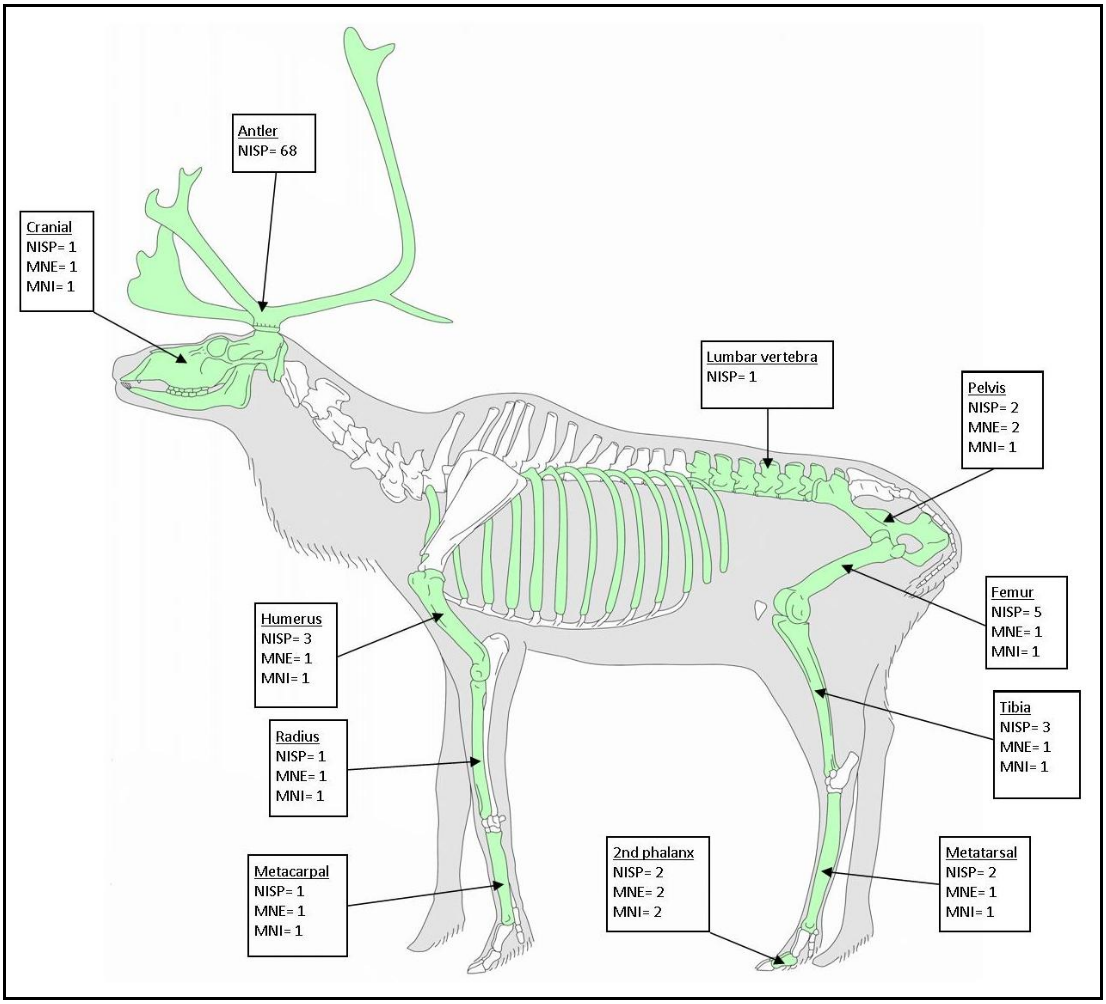

Figure 6.33 Reindeer skeletal representation with NISP, MNE, and MNI values
Skeletal outline modified from Yvinec *et al* (2007)

Predator-scavenger modification

Reindeer exhibit a similar distribution of predator-scavenger modification as the mammoth fauna, though the number of preserved specimens is significantly reduced (see Appendix 3 Table 20 and Figure 6.34). The long bone gnawing is again confined to the epiphyses, as illustrated by a gnawed off femur head and crenelation along the edges of long bone fragments, where carnivores have scraped out the marrow cavity (see Binford, 1981; Brain, 1981) (see Figure 6.35). Similarly the tooth pit and crenelation around the 2nd phalanx proximal epiphysis highlights modification to gain access to the marrow cavity (see Figure 6.36). Haynes (1980) documents evidence of wolf gnawing and consumption of modern reindeer antlers when in velvet. Five specimens were recovered from the Lynford assemblage with gnawing and tooth pits, furrowing and crenelation mainly on tines (see

Figure 6.37). Only one of these specimens was naturally shed, although it is possible that the others had died when their antlers were in velvet.

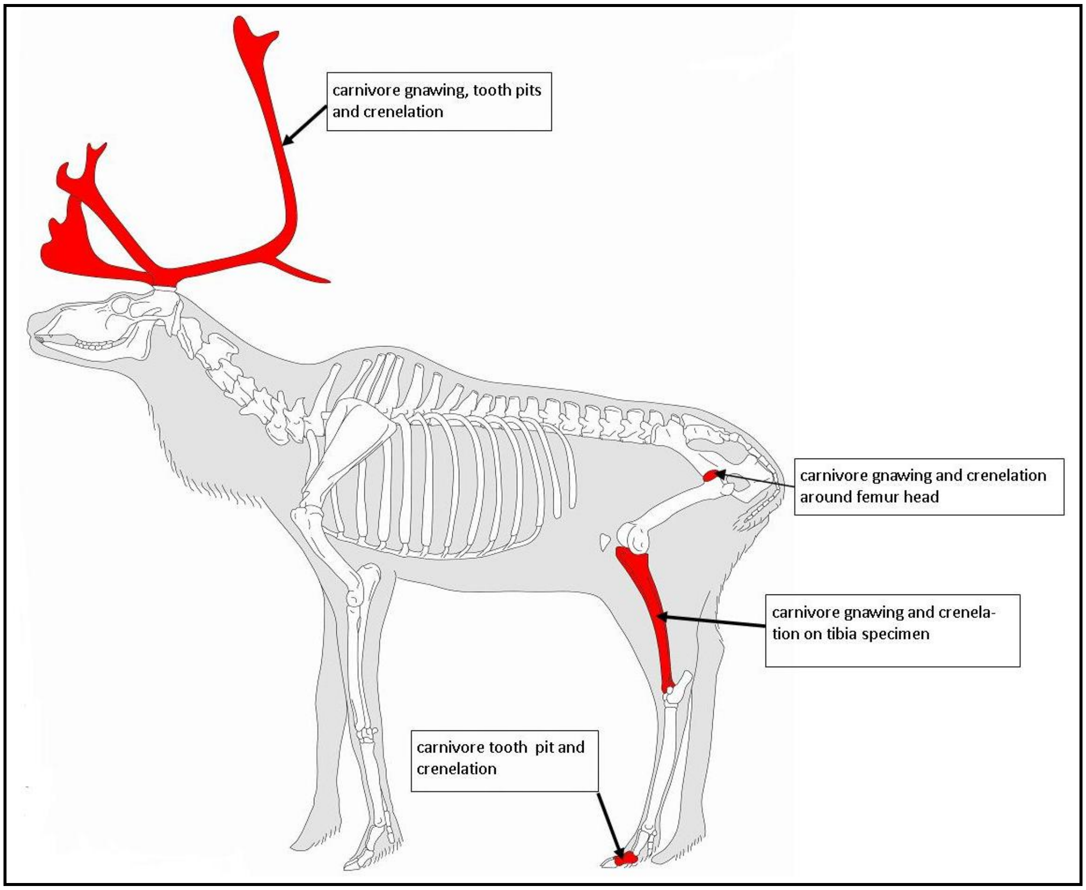

Figure 6.34 Distribution of predator-scavenger modification across reindeer skeleton Skeletal outline modified from Yvinec *et al* (2007)

Figure 6.35 Reindeer femur head (LYN 50823) with predator-scavenger crenelation

Figure 6.36 Reindeer 2nd phalanx (LYN 51202) with predator-scavenger tooth pit

Figure 6.37 Antler (LYN 51589) with evidence for predator-scavenger gnawing

Hominin modification

Hominin modification of reindeer elements includes deliberately fractured femur, humerus, metatarsal and indeterminate long bone shafts (NISP= 6), suggesting exploitation for marrow (see Appendix 3 Table 21 and Figure 6.38). Some of these specimens demonstrate impact notches and radial scarring caused by the impact and force of the blow required to crack open the shaft cavity (see Figure 6.39 and Figure 6.40). This is similar to modification highlighted by Binford (1981) and others (see Chapter 5; Roberts and Parfitt, 1999a) as indicative of long bone marrow extraction. This pattern suggests perhaps an absence of meat on the reindeer skeleton and indicates marrow-processing.

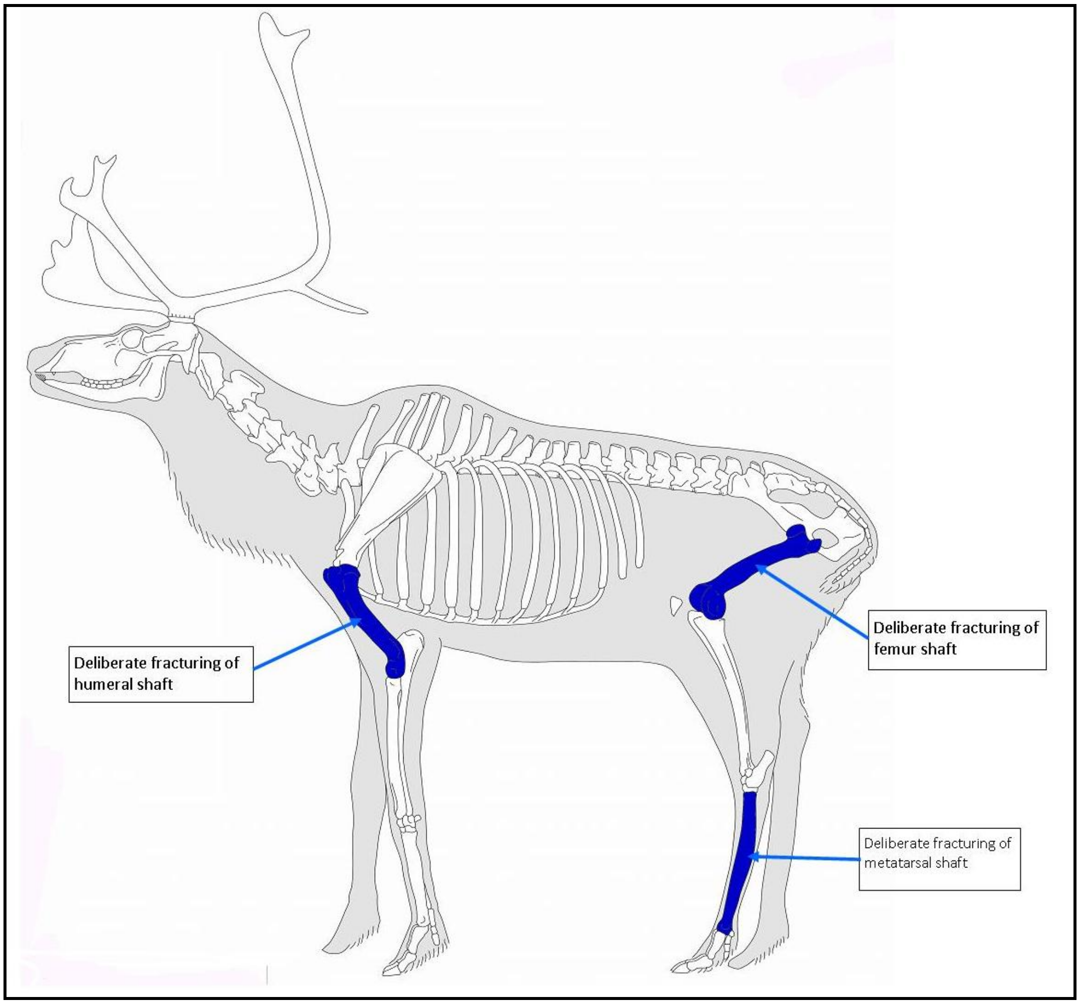

Figure 6.38 Distribution of hominin modification across reindeer skeleton
Skeletal outline modified from Yvinec *et al* (2007)

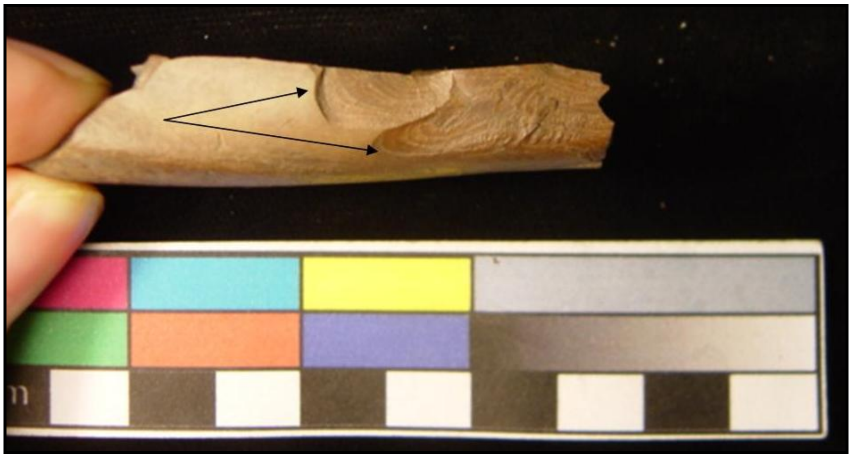

Figure 6.39 Reindeer humeral shaft (LYN 51786) with hominin impact point from marrow-processing

Figure 6.40 Reindeer indeterminate long bone fragment (LYN 50326)
With hominin impact point from marrow-processing

6.6 Equid

6.6.1 Horse

Horse (*Equus ferus*) remains are limited (NISP=7) and the low MNI (MNI= 1; astragalus) confirms the pattern of few individuals highlighted for other species (see Appendix 3 Table 22). The preservation of dense femur portions (midshaft and distal epiphysis) and complete tarsal bones (astraglus and calcaneum) appears to suggest a density-mediated survival similar to that displayed by other species, though the size of the assemblage questions the significance of this pattern. The survival of teeth (NISP= 4) supports the limited number of individuals represented in the sample. The absence of other elements, mirrors the bison pattern, and may reflect the destruction of elements by natural processes rather than the removal of elements through predator or cultural selectivity (see below).

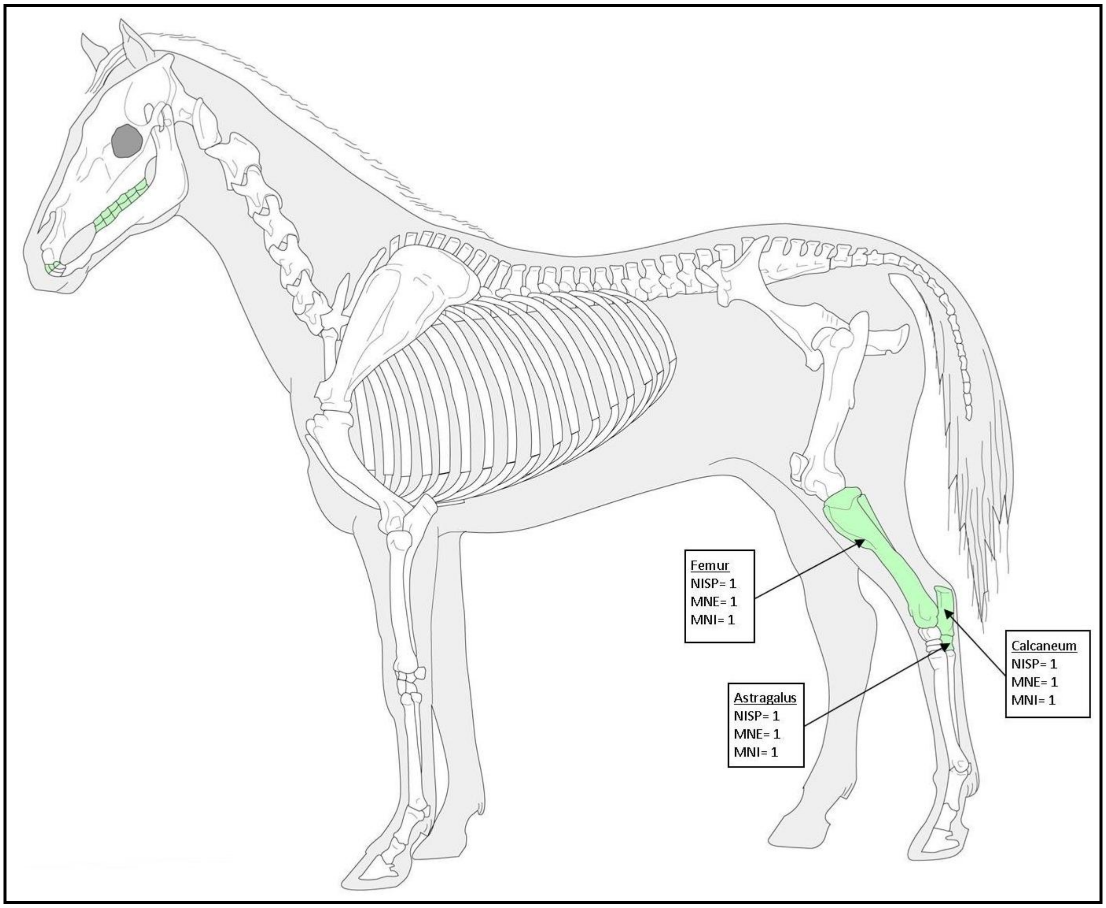

Figure 6.41 Horse skeletal representation with NISP, MNE and MNI values
Skeletal outline modified from Yvinec *et al* (2007)

Predator-scavenger modification

Predator-scavenger gnawing and tooth marks have been identified on a femoral distal epiphysis, along with evidence for deliberate fracturing by hominins. The location of this modification, on the condyles and epicondyles suggests that the femur was still articulated to the tibia when the predators were exploiting this carcass (see Figure 6.42), presumably to consume any remaining meat on the bone. The deliberate fracturing of the femoral shaft appears to have occurred subsequent to the predator-scavenger modification and indicates these communities had primary access to elements from this carcass (see below).

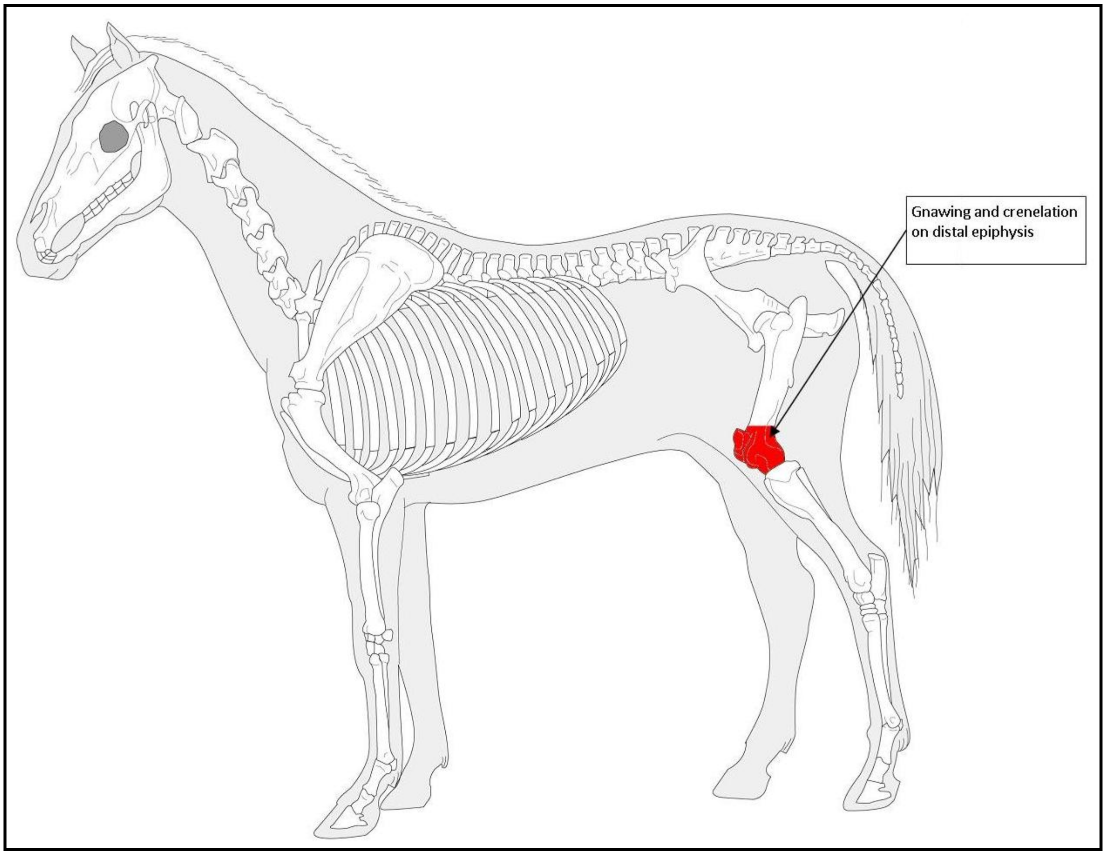

Figure 6.42 Distribution of predator-scavenger modification across the horse skeleton Skeletal outline modified from Yvinec *et al* (2007)

Figure 6.43 Predator-scavenger gnawing and crenelation around femur distal epiphysis Note: width of specimen 93.2mm

Hominin modification

Hominin modification of horse remains include a deliberately cracked femur shaft (NISP= 1) and fractured molar (NISP= 1) indicating marrow extraction (see Figure 6.44 and Figure 6.45). Tooth fractures possibly relates to the cracking of the mandible for marrow extraction (see Chapter 5, Section 5.5.1). The site of Mauran (France), highlights mandibular fracturing, though the authors are uncertain as to whether such a breakage has occurred naturally (Farizy *et al.*, 1994). Research is still ongoing at present to attempt and isolate further instances of such behaviour during the Middle Palaeolithic.

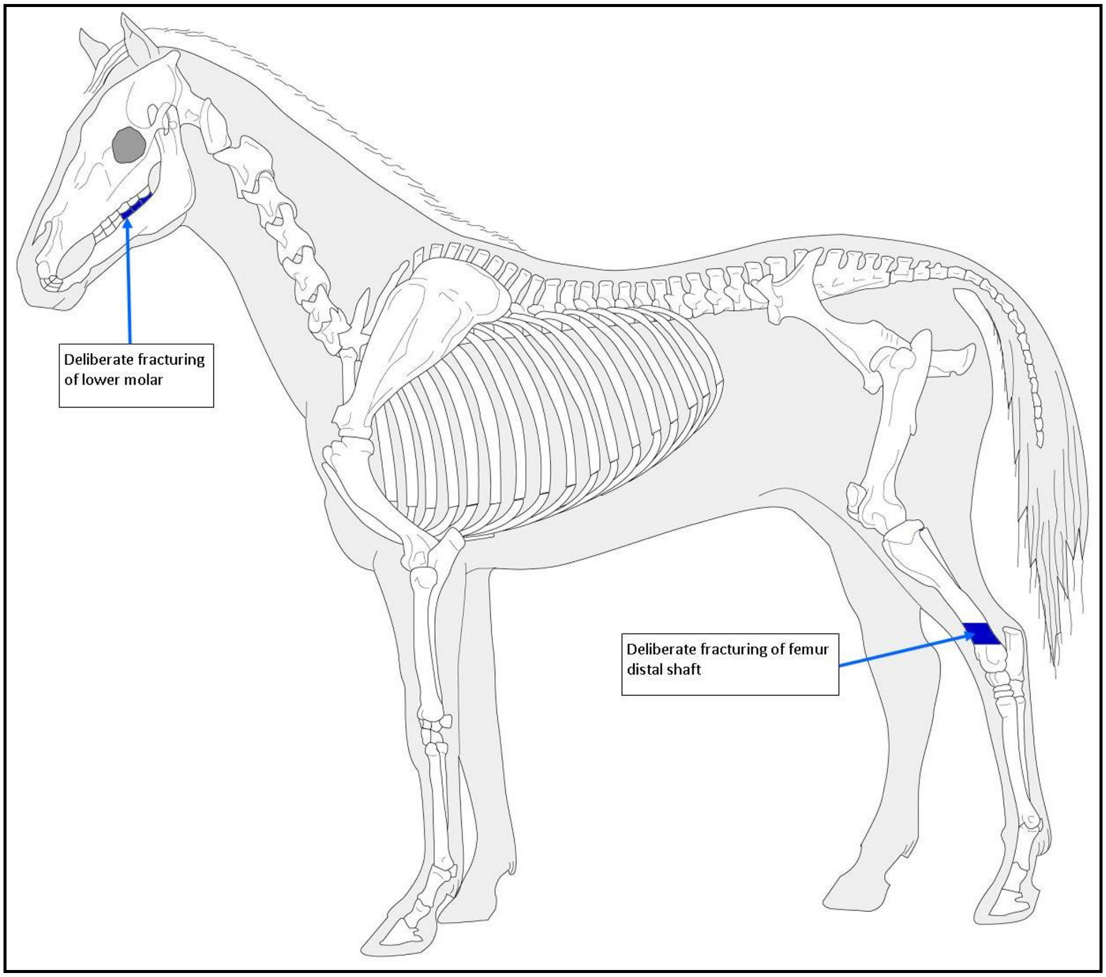

Figure 6.44 Distribution of hominin modification across the horse skeleton
Skeletal outline modified from Yvinec et al (2007)

Figure 6.45 Deliberately fractured horse lower molar (LYN 51613)

6.7 Bovid

6.7.1 Bison

Bison (*Bison priscus*) are poorly represented (NISP= 4), and only by appendicular elements (humerus, radius and metatarsal) illustrating a small minimum number of individuals (MNI=1; humerus) (see Appendix 3 Table 23). The limited number of preserved elements does not permit a discussion of skeletal fragmentation. Upon closer examination the surviving portions once again appear to represent the densest portions of those elements (humerus- distal epiphysis and shaft; radius- proximal epiphysis) (Stopp, 1997). Previous studies have demonstrated that metapodials are some of the densest elements in the bison skeleton (Kreutzer, 1992), and the survival of a near complete specimen possibly indicates further density mediated preservation. The absence of both cranial and postcranial elements is interesting, though fragments could be masked by the large quantities of indeterminate fragments (see above) and may have been destroyed through the natural attrition of the faunal assemblage. However, the presence of predator-scavenger modification (see below) could also indicate the removal and destruction of elements by these species.

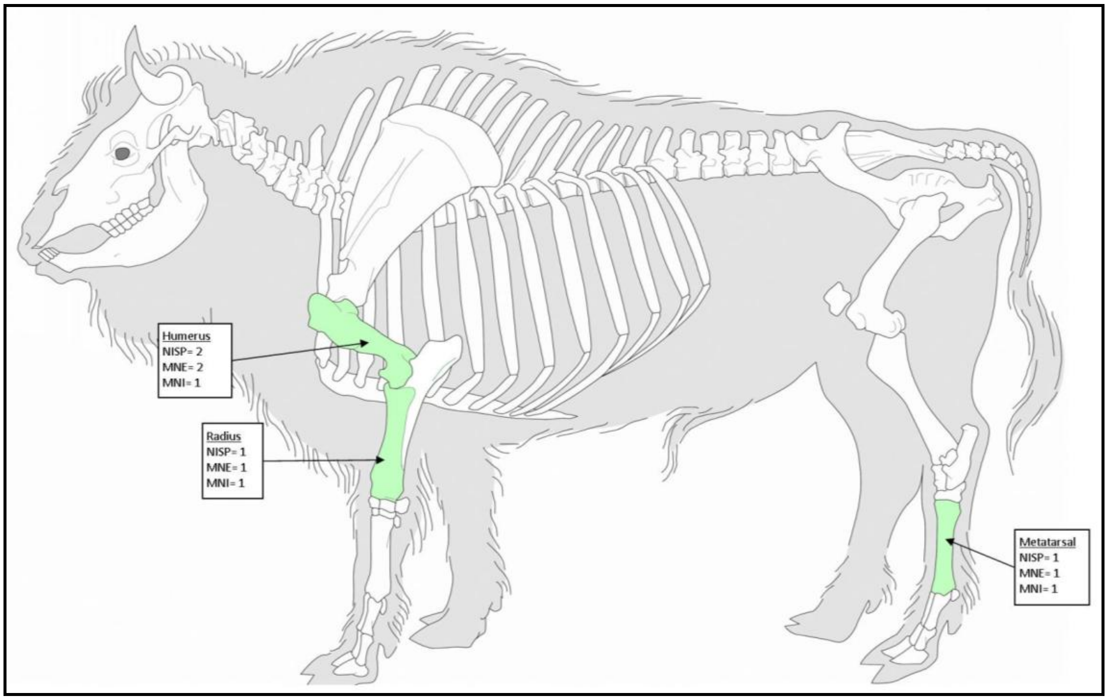

Figure 6.46 Bison skeletal representation with NISP, MNE and MNI values
Skeletal outline modified from Yvinec *et al* (2007)

Predator-scavenger modification

Modification of a bison humerus exhibits the same pattern as other Lynford species with gnawing, tooth pits and crenelation around the distal epiphysis indicating sustained carnivore modification (see Figure 6.47). This modification indicates attempted marrow-processing by wolves which do not possess the mechanical ability to crack through the dense shaft. The presence of carnivore impact points on the longbone shaft probably reflects cracking of the marrow cavity by hyaenas, subsequent to the epiphysis modification. This specimen neatly highlights the repeated return and reuse of resources by predator-scavengers at the site, which is further supported by analysis of the weathering and other natural modification agents.

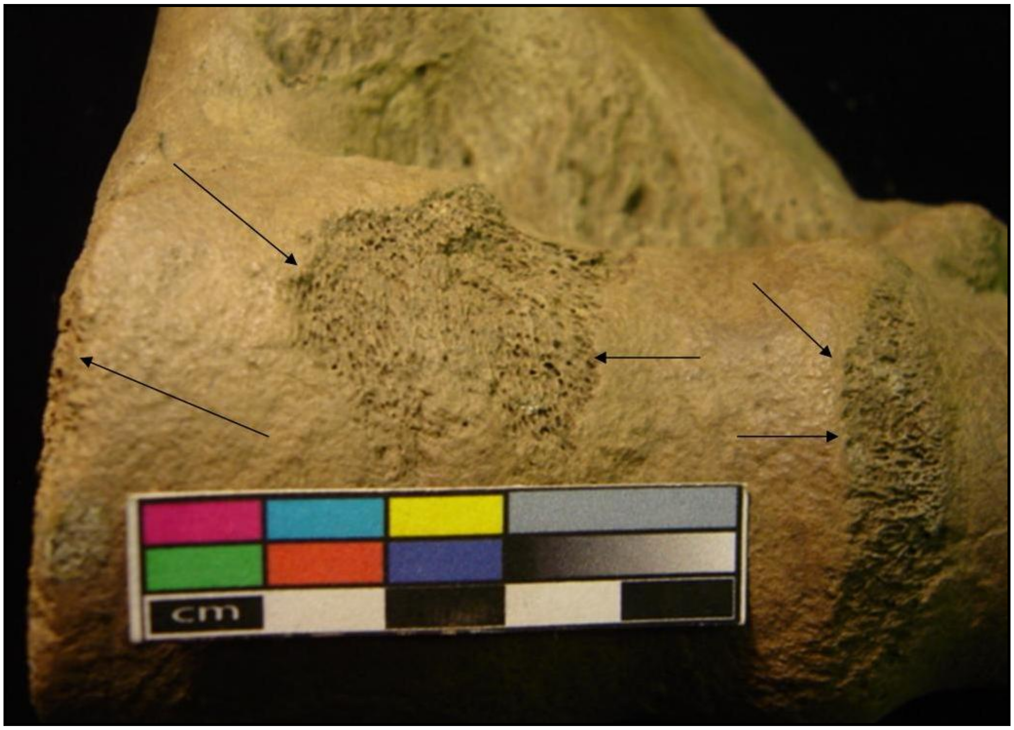

Figure 6.47 Distal bison humerus with extensive predator-scavenger gnawing

6.8 Indeterminate species

It is important at this stage to consider the indeterminate fragments which comprise 26.6% of the preserved assemblage (NISP= 935) and that cannot be assigned to a particular species (large mammal NISP= 58) (see Appendix 3 Table 24 and 25). The size and quantity of the indeterminate specimens (average length= 47.2mm; including large mammal fragments) suggests heavy fragmentation of skeletal remains, and could thus explain the absence of identifiable skeletal elements. Similarly, the indeterminate cranial fragments (41.1%) points to the *in situ* destruction of complete/near complete crania on site, which is supported by the small mean fragment length (42.9mm), when compared to identifiable mammoth cranial fragments (148.1mm). The absence of certain categories might not reflect a true pattern but rather *in situ* fragmentation through attritional taphonomic processes, masking identifiable skeletal elements for all species at the site.

Predator-scavenger modification

An indeterminate large mammal scapula exhibits crenelation along the vertebral border of the blade (see Figure 6.48), and follows with the normal pattern of carnivore modification highlighted by Binford (1981). The gnawing of the scapula is not related to marrow extraction but probably reflects the removal of small quantities of animal tissue during the consumption.

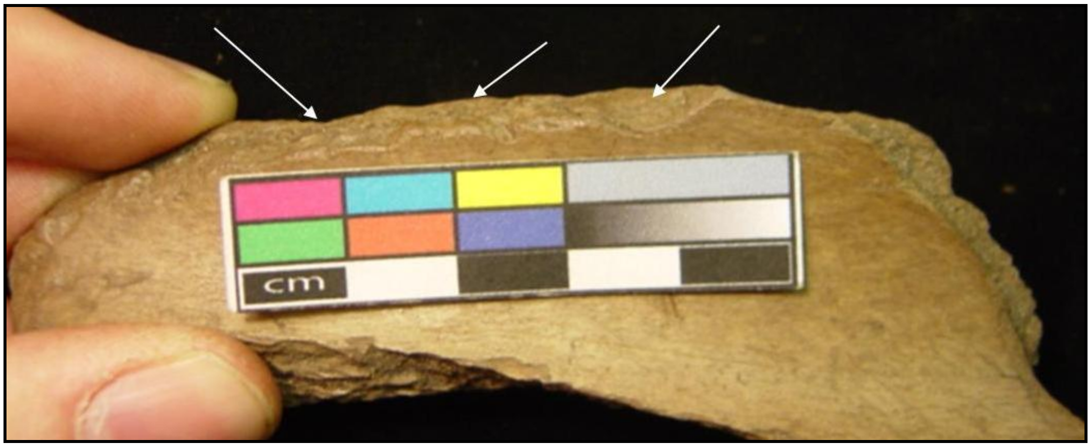

Figure 6.48 Large mammal scapula fragment with predator-scavenger crenelation

6.9 Assemblage fracture patterns

There is evidence for bone fracturing in the assemblage (NISP= 16), though experimental observations have highlighted that numerous agents can produce similar fracture morphologies (see Bonnichsen and Sorg, 1989; Brain, 1981; Smith, 2003b). There are numerous fracture types displayed including spiral; saw toothed; longitudinal; and flaking. Furthermore, only a small number cannot be assigned to a specific agent (n= 6) (see Table 6.2). These fractures are saw toothed (n= 2) and longitudinal (n= 4) indicating that the bone was relatively old and brittle when broken (Haynes, 1991). Spiral fractures (n= 4) related to predator-scavenger and hominin breakage indicates that the bone was fresh when broken and indicates marrow extraction. The presence of fractured molar teeth (n= 3) suggests that hominins were similarly cracking mandibles to extract marrow. The longitudinal fracturing of mammoth limb bones (n= 3) by carnivores indicates the bone was older and more brittle, and suggests repeated return and reuse of bone nutrients at the site.

Although the evidence for the spiral fracturing of long bones points to hominin and predator-scavenger populations removing the marrow, natural causes such as trampling can produce similar bone surface modification patterns (see Bonnichsen and Sorg, 1989; Haynes, 1991). Indeed, Haynes (1991) notes that spirally fractured elephant limb bones trampled by animals demonstrate notched edges that appear similar to the impact damage created by hominins. It is therefore possible that the fractured faunal elements that cannot be ascribed to a particular agent are the result of natural trampling by other animals around the waterhole. Indeed the presence of three distinct fracture types spiral (n= 3); saw toothed (n= 2); and longitudinal (n= 1) suggests a time averaged assemblage with fracturing occurring when the bones were at different stages of decay and brittleness.

Species	Element	Fracture Type[8]	Fracture Edge	Modification	Type
Mammuthus primigenius	Tusk	ST	Rough	No	Natural
	Rib	SP	Rough	No	Natural
	Humerus	LT	Rough	No	Natural
	Femur	LT	Rough	**Yes**	**Pred/Scav**
	Tibia	LT	Rough	**Yes**	**Pred/Scav**
	Ulna	LT	Rough	**Yes**	**Pred/Scav**
Rangifer tarandus	Rib	ST	Rough	No	Natural
	Humerus	SP	Rounded	No	Natural
	Indet tibia	SP	Rough	**Yes**	**Pred/Scav**
	Metatarsal	SP	Rounded	**Yes**	**Hominin**
	Indet long bone	SP	Rough	**Yes**	**Pred/Scav**
Coelodonta antiquitatis	Molar	LT	Rough	**Yes**	**Hominin**
	Molar	FL	Rough	**Yes**	**Hominin**
Bison priscus	Humerus	SP	Rounded	**Yes**	**Pred/Scav**
	Metatarsal	SP	rounded	No	Natural
Equus ferus	Lower molar	IP	Rough	**Yes**	**Hominin**

Table 6.2 Element fracturing by species and element
And whether the fracture relates to a specific taphonomic agent

Most of the fresh bone spiral fractures (6/7; 85.7%) are on medium-sized species (reindeer, bison; see Figure 6.49) whereas most of the brittle fracture types (saw toothed, longitudinal, perpendicular) are mainly on the megafaunal species (80%). The variation in fracture types by species suggests that the megafaunal remains (mammoth and woolly rhino) have been exposed for varying periods of time whilst the medium-sized species may have been introduced into or processed at the site as more complete carcasses. The variance in bone fracture patterns highlights the addition to and modification of faunal material over a

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[8] Key
ST- saw toothed
SP- spiral
LT- longitudinal
FL- flaking
IP- irregular perpendicular

prolonged period and reinforces the hypothesis of a palimpsest assemblage, as indicated by the bone weathering data. To conclude, there is evidence for deliberate bone fracturing by hominins and carnivores to extract marrow from both long bones and mandibles. Additionally, evidence for carnivore and hominin fracturing on older more brittle bone suggests repeated return to and reuse of the site (see below).

Figure 6.49 Bison humerus with spiral fracture indicative of fresh bone fracture Note the rounded fracture edge suggestive of hydraulic modification

6.10 Discussion

The faunal material from Lynford was recovered from the lacustrine deposits, the deposition of which has had a relatively minimal impact on the faunal remains in terms of pre, and post depositional disturbance (Morton, 2004). The long axes of faunal remains do not appear to be orientated in the direction of river flow but rather aligned with the bank slumping and sediment gravity flows along the edges of this palaeo-channel. The limited evidence for hydraulic rounding demonstrates that water did not significantly modify these remains, which would have resulted in what Isaac (1983) terms a ‘hydraulic jumble’.

The limited effect of hydraulic action is confirmed when observing data from the natural modification and weathering of the faunal assemblage. Most of the natural modification relates to the terrestrial weathering of these remains, and the presence of root etching suggests exposure and incorporation into the surrounding terrestrial ecosystem. Extensive abrasion (pitting and scratching) on the bone surface suggests prolonged exposure and relates to the trampling of these remains both prior to burial and during the slumping of material from bank collapse. Use of Behrensmeyer's (1978) weathering stages highlighted variation in the degree of weathering and suggested the repeated input and exposure of faunal material, thus producing a varied pattern of exposure. The general weathering pattern holds true for the well preserved mammoth fauna, though the small numbers of other species prevents a broader analysis. Interestingly, the reindeer bones demonstrate a pattern of survival indicating relatively rapid burial with most elements lightly weathered (stages 0, 1 and 2), suggesting that these remains were deposited at the site as a more homogenous assemblage: a pattern corroborated by the skeletal representation, which highlights a small number of individuals (MNI= 2). The accumulation of the faunal material appears to be the result of numerous temporally separate events along the edge of this lake-like environment, rather than a single homogenous mass death (Haynes, 1987, 1991).

Studying the skeletal representation has produced an ambiguous pattern for assemblage genesis that could have been caused either naturally or through accumulation by other agents. Analysis of the skeletal representation highlights considerable fragmentation for most species, though this is particularly evident for mammoth remains where Lister (in press) identifies 11 individuals contra the preserved postcranial skeletal elements which suggest only 3. To recap, the fragmentation at Lynford could have been caused by animal trampling around the lake margins and modification by hominins and predator-scavengers (see below and Haynes, 1988a).

The reindeer remains showed an absence of cranial and axial elements which is possibly related to the removal of these portions (certainly vertebrae) by hominins or predator-scavengers, or the *in situ* destruction of these elements by natural processes. Nevertheless, it appears that reindeer was introduced into the site as a more homogenous assemblage, as illustrated by the similarity in bones' weathering pattern (see 6.2). The poor representation of skeletal elements for other species (woolly rhino, horse, and bison) has meant that the discussion of any patterns observed is tenuous because of the small sample size.

6.10.1 The role of hominins and predator-scavengers

The presence of hominin and predator-scavenger modification, and minimal disturbance by natural agents (see 6.2 and 6.3), allows for a detailed discussion of potential predator-scavenger/hominin interaction and thus subsistence strategies.

The preserved carnivore and hominin modification highlights an interesting pattern of subsistence and carcass use. Predator-scavenger modification was recorded across most of the preserved species, and importantly, on the megafauna at similar locations to that identified by Binford (1981) during his work on wolf-modified kill sites. Much of the modification appears to relate to the extraction of marrow from long bones and is concentrated around the long bone epiphyses, although crenelation was noted along some shaft fragments. Although the majority of the modification suggests scavenging, the location of carnivore gnawing on a horse femur suggests articulation with the tibia and indicates that carnivores may have had primary access to remaining muscle tissue. Similarly, the presence of predator-scavenger gnawing along the mammoth iliac spine suggests the presence of small amounts of animal tissue. Likewise, crenelation and notches on the edge of mammoth ribs, where a considerable amount of meat is located, may relate to disarticulation by carnivores and indicate the availability of meat on these carcasses. Haynes (1980) documents wolf gnawing on reindeer antler in velvet, during the spring/summer, to take advantage of the highly nutritious layer of blood vessels, which provides a time frame for the period of mortality.

Stone tools within the same horizons as the faunal remains indicate the presence of hominin populations in the surrounding locale. Hominin modification is noted throughout the assemblage (NISP= 12), but is less common than carnivore modification. There is no direct evidence for cut marks on the faunal remains, and it is not certain that the lithics and preserved fauna are associated. The only evidence for hominin modification on the preserved fauna are the marrow cracked long bones and fractured teeth. The evidence appears to suggest that hominin populations were employing a more passive strategy similar to predator-scavengers, focussed on marrow. Marrow extraction from the horse femur appears to indicate secondary access to the marrow, subsequent to carnivore gnawing.

Importantly, there is no evidence for systematic megafaunal exploitation by hominin communities, contradicting previous interpretations of this faunal assemblage (Schreve, 2006). Schreve has suggested that the large muscle packages on the megafauna could be removed without necessarily marking the bone, though other earlier sites, such as Boxgrove and La Cotte de St Brelade, illustrate evidence for identifiable megafaunal exploitation (see Chapter 5; Roberts and Parfitt, 1999b; Schreve, 2006; Scott, 1980). The differential fracturing of longbones suggests that material may have been exposed and modified at this location either by natural processes or other predator-scavengers (Haynes, 1980, 1985, 1988a, 1988b). Lister's (in press) age determinations for the Lynford mammoths indicate that the majority of individuals were of prime age, with a few younger and elderly individuals, comparing favourably with Haynes' Type C mortality profile. It is assumed that mammoths, like modern elephants, had a matriarchal social structure (Haynes, 1991), and the identification of adult male individuals from Lynford suggests that the faunal assemblage does not represent the mass death of a matriarchal herd (Lister, in press); Haynes has documented all-male death assemblages, which have a similar age structure to the Type C mortality profile detailed above (Haynes, 1991). The presence of male individuals and attritional bone weathering data indicates that mammoth remains accumulated naturally, as part of an all male death assemblage, that was subsequently exploited by predator-scavengers.

The Lynford fauna represents a palimpsest deposit with well-preserved faunal evidence for predator-scavenger and hominin modification. The preserved faunal assemblage represents the natural accumulation of megafauna (mammoth, woolly rhino) and medium-sized species (reindeer, bison, horse) around a meander cut-off or oxbow lake (see for example Morton, 2004). The identification of dung and carrion beetles, coprolites and lithic tools suggests that this location was an important focal point and heavily utilised by both hominins and other animals (Coope, in press; Schreve, 2006). The seasonal temperature variation (-13 to 10°C) would undoubtedly have influenced the behaviour of both hominin and other animal communities (Coope, in press). Overall both hominin and predator-scavenger modification of the faunal remains suggests that these communities were repeatedly returning to a known location to exploit available resources. Both hominins and predator-scavengers subsistence appears to have been focussed on marrow and other nutrients (e.g. brain) and it appears that there was a limited amount of meat available on these carcasses; although some specimens do show that predators-scavengers had primary access to remnants of flesh on some elements. There is no evidence for hominin megafaunal hunting, though it is possible that reindeer were hunted during their seasonal migration, though the evidence for this is limited by small sample sizes and, as such, should be regarded as a hypothesis, with further investigation required. The variation in winter and summer temperatures would have required migration by Neanderthals and other species, with the cold temperatures providing a ‘natural freezer’ that preserved skeletal elements and nutrients allowing predator-scavenger and human populations to repeatedly exploit marrow and other meat sources, probably during the warmer periods. This interpretation of Neanderthal subsistence highlights adaptability, pragmatism and a holistic use and understanding of their surrounding resource environment.

Chapter 7 Swanscombe analysis and results

7.1 Species specific preservation and modification

The faunal assemblage analysed comprises 504 specimens of which 177 were identifiable to species. The identifiable assemblage is dominated by fallow deer (NISP= 138; 27.4%) although other cervid species are recorded in smaller quantities (*Cervus elaphus*, NISP= 16, 3.2%; *Megaceros giganteus*, NISP= 1; 0.2%) (see Appendix 4 Table 1 and Figure 7.1). The *Cervidae sp indet.* category represents the largest quantity of faunal specimens from the site (NISP= 279; 55.4%). These specimens could, in theory, relate to any of the three cervid species identified and so will be considered alongside the remains of identifiable cervids throughout the analysis. The remaining large-medium sized assemblage includes at least two species of extinct rhinoceros *Stephanorhinus hemitoechus* (NISP= 1, 0.2%); *Stephanorhinus kirchbergensis* (NISP= 4, 0.8%); and *Stephanorhinus sp* (NISP= 7; 1.4%) along with species such as elephant (NISP= 9; 1.8%), bison (NISP= 1; 0.2%), wild cattle (NISP= 1; 0.2%) and an indeterminate bovid (NISP= 41; 8.1%). The indeterminate portion of the assemblage is relatively small (NISP= 6; 1.2%), although this fact could be related to the collection methods employed, whereby only the larger, more identifiable portions were collected (Currant, *pers comm.*). In the original site report Schreve (1996) documents the presence of equid remains, though none of these could be located during data collection for this project and so could not be studied at first hand, and compared with Schreve's original analysis.

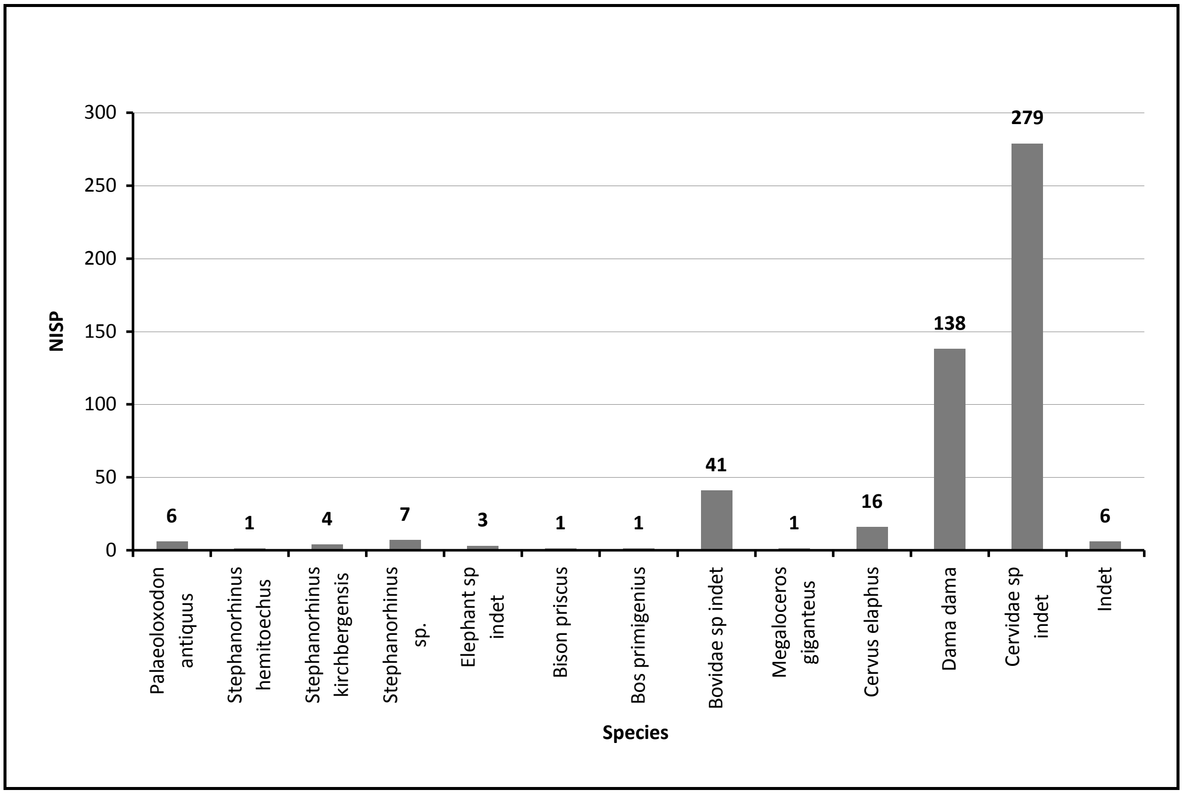

Figure 7.1 NISP counts by species

The geological sequence at Swanscombe consists of 12-15m of terrace deposits representing the infilling of the Anglian channel during the Hoxnian interglacial (400-350kya) (see Chapter 4, Conway *et al.*, 1996; Roberts *et al.*, 1995). The majority of faunal remains were recovered from the Lower Gravel and Lower Loam though occasionally specimens were recovered from the Middle Gravels (see Appendix 4 Table 2 and Figure 7.2) (Conway *et al.*, 1996; Waechter, 1968, 1969).

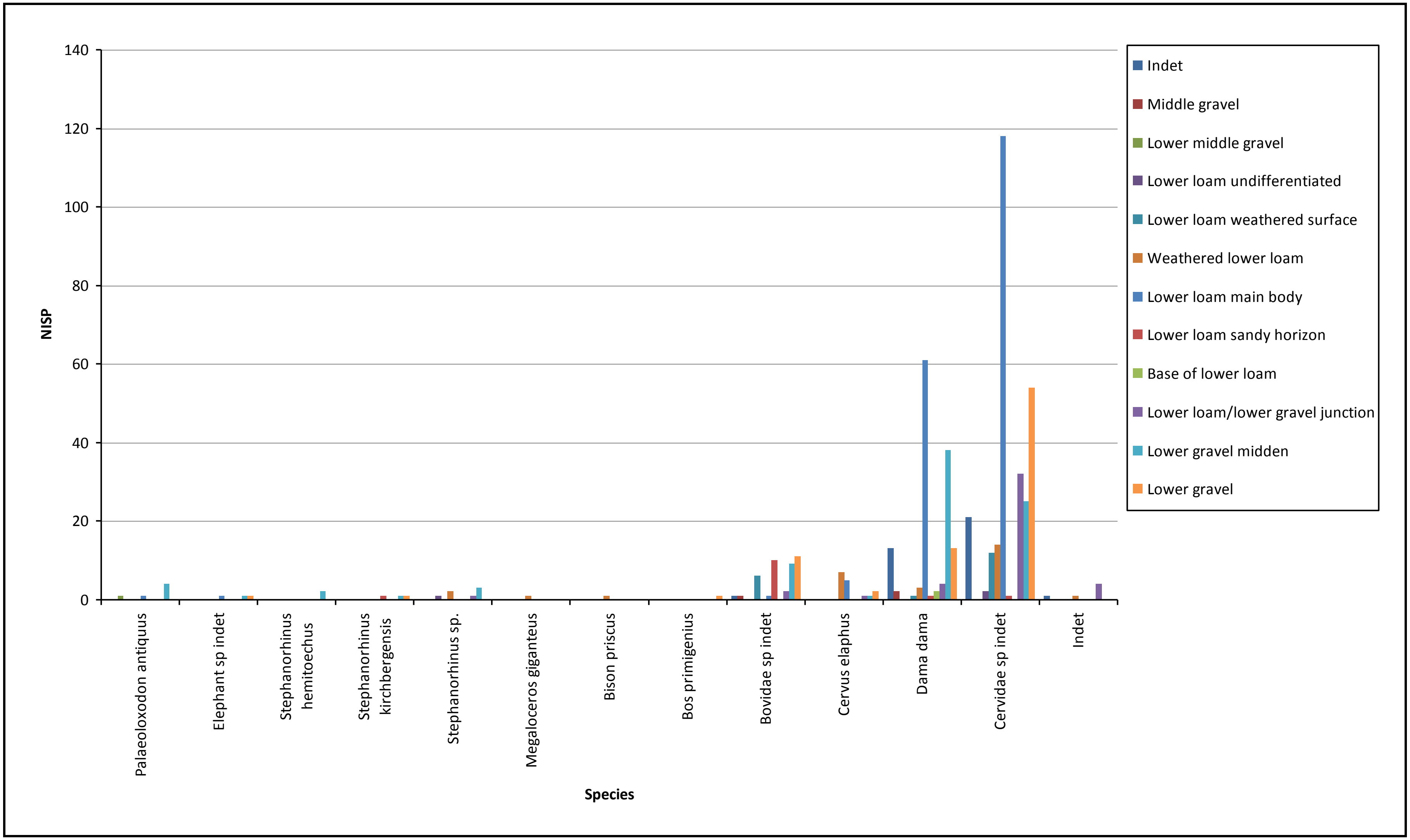

Figure 7.2 Distribution of species throughout the Swanscombe contexts

The Lower Gravels are fluvial in origin and contain molluscs, mammals and pollen that indicate fully temperate conditions (Conway *et al.*, 1996). The Lower Loam was deposited within a small channel cut into the top of the Lower Gravel and this change in depositional environment, from gravel to loam, illustrates a change from a high to low energy flow regime. The ostracod and mollusc data from the Lower Loam also demonstrates significant variation between clear running water and more stagnant conditions (Robinson, 1996) perhaps indicating the migration of the river system across the flood plain. Such data suggests that the Lower Loam could represent overbank sediments deposited in an abandoned meander channel margin (Robinson, 1996) or river section that was intermittently connected to the main river system. An alternative explanation of the Lower Loam is that it could represent a decalcified tufa (Currant *pers* comm.) perhaps formed as a spring deposit at the base of the chalk, and appearing on the surface as a slow moving stream deposit cutting a channel into the upper surface of the Lower Gravel. The high levels of calcium carbonate within such a deposit would have helped to preserve the faunal remains and could explain the relatively large concentration of material in this horizon. Additionally, the deflation of this horizon could explain why some of the bones recovered were severely crushed. The presence of over bank deposits within the Lower Loam illustrate periodic flooding events and suggests the continued migration of the river system in and around the site locale (Roberts *et al.*, 1995).

The sedimentary sequence at Swanscombe, as indicated by the change in flow regimes, highlights the evolution and migration of a river system from the high energy Lower Gravel to the low energy Lower Loam. The depth of deposits at Swanscombe (12-15m) means that the lithic and faunal material does not represent the accumulation of material that can be both spatially and temporally linked (see Boxgrove). The coarseness of the deposits prevents large scale refitting, though the Lower Loam provides some evidence for lithic refitting and faunal association though this is limited in comparison to that observed at Boxgrove, and will be discussed later (see Sectioin 7.9.1). The evolution of the river system at Swanscombe appears to have been a major factor in site formation and modification, with varying rates of accumulation and types of material. Therefore, it is vital to establish the role of the river in the accumulation and distribution of faunal material at and within the wider context of the fluvial system.

7.2 Weathering

Weathering was recorded across the entire assemblage (using Behrensmeyer, 1978), though the general weathering patterns suggests that the faunal material was not exposed for long periods of time, or re-exposed later (see Appendix 4 Table 3 and Figure 7.3) . The general pattern shows that the majority of specimens were either exposed to limited sub-aerial weathering (Stage 1= 43.5%, Stage 2= 15.3%) or were unweathered (Stage 0= 39.1%) with very few specimens recorded in the medium-heavily weathered stage (Stage 3=1.8%, Stage 4= 0.4%). Such a pattern would appear to demonstrate that the faunal material was exposed to terrestrial weathering for a relatively short of period time before being incorporated into the underlying sediments.

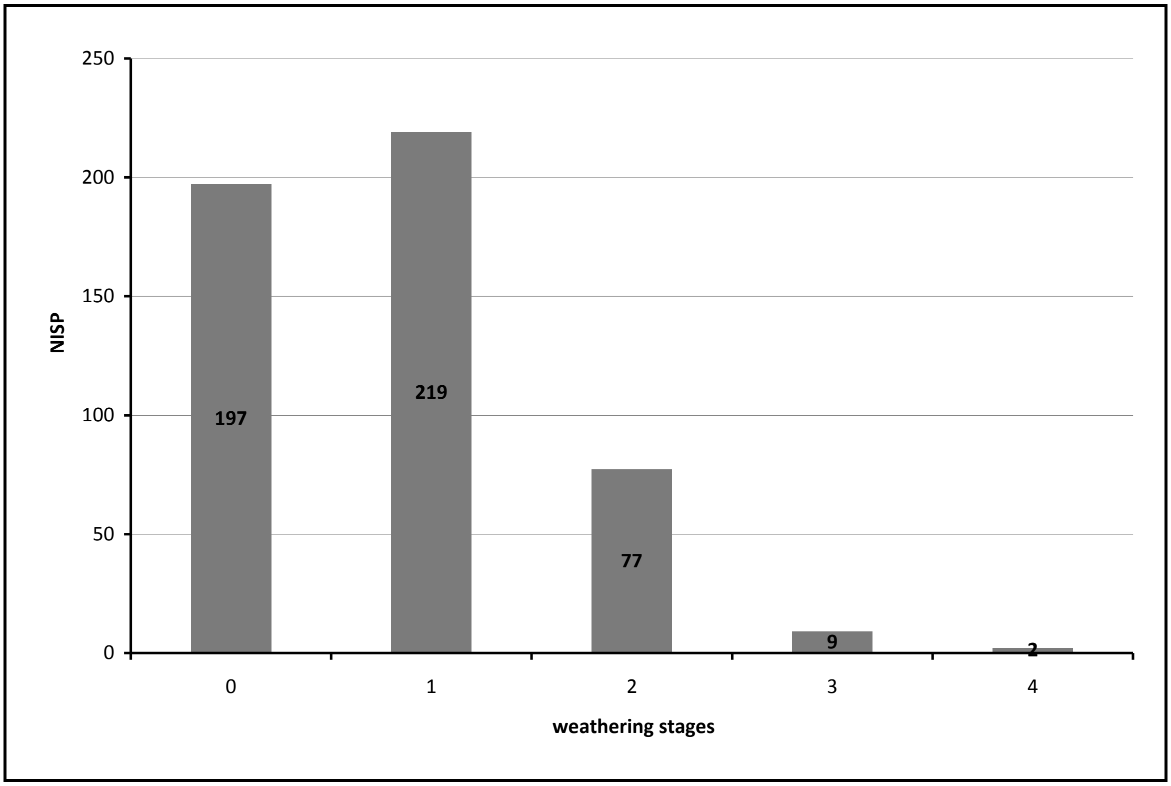

Figure 7.3 General weathering of Swanscombe faunal assemblage

The average length and width of the faunal specimens from each weathering stage was calculated and indicates that those specimens more heavily weathered had, on average, larger dimensions (see Table 7.1).

Weathering Stage	Average Length (mm)	Average Width (mm)
0	80.4	27.1
1	98.1	32.0
2	128.4	36.7
3	199.1	43.0
4	305.0	170.0

Table 7.1 Average dimensions of faunal specimens from each weathering stage

However, it should be noted that the average length and width of the most heavily weathered categories are only based on a small number of specimens. The fragmentation of the assemblage combined with the low amount of sub-aerial weathering, and the absence of faunal refitting within or between the contexts perhaps suggests that the material was incorporated quickly into these deposits and subsequently fragmented by other modification agents (see Section 7.3).

The distribution of faunal material within the sedimentary sequence highlights a concentration within the Lower Gravel and Lower Loam, though interestingly the weathering patterns within these deposits is similar to the general pattern highlighted above (see Appendix 4 Table 4 and Figure 7.4). Most of the faunal material is either unweathered or lightly weathered. The similarity in the pattern between these contexts is interesting considering that these units were deposited under different conditions (gravel: high energy; loam: lower energy). A similar weathering pattern was recorded for each of the animal species recorded at the site (see Appendix 4 Table 5 and Figure 7.5).

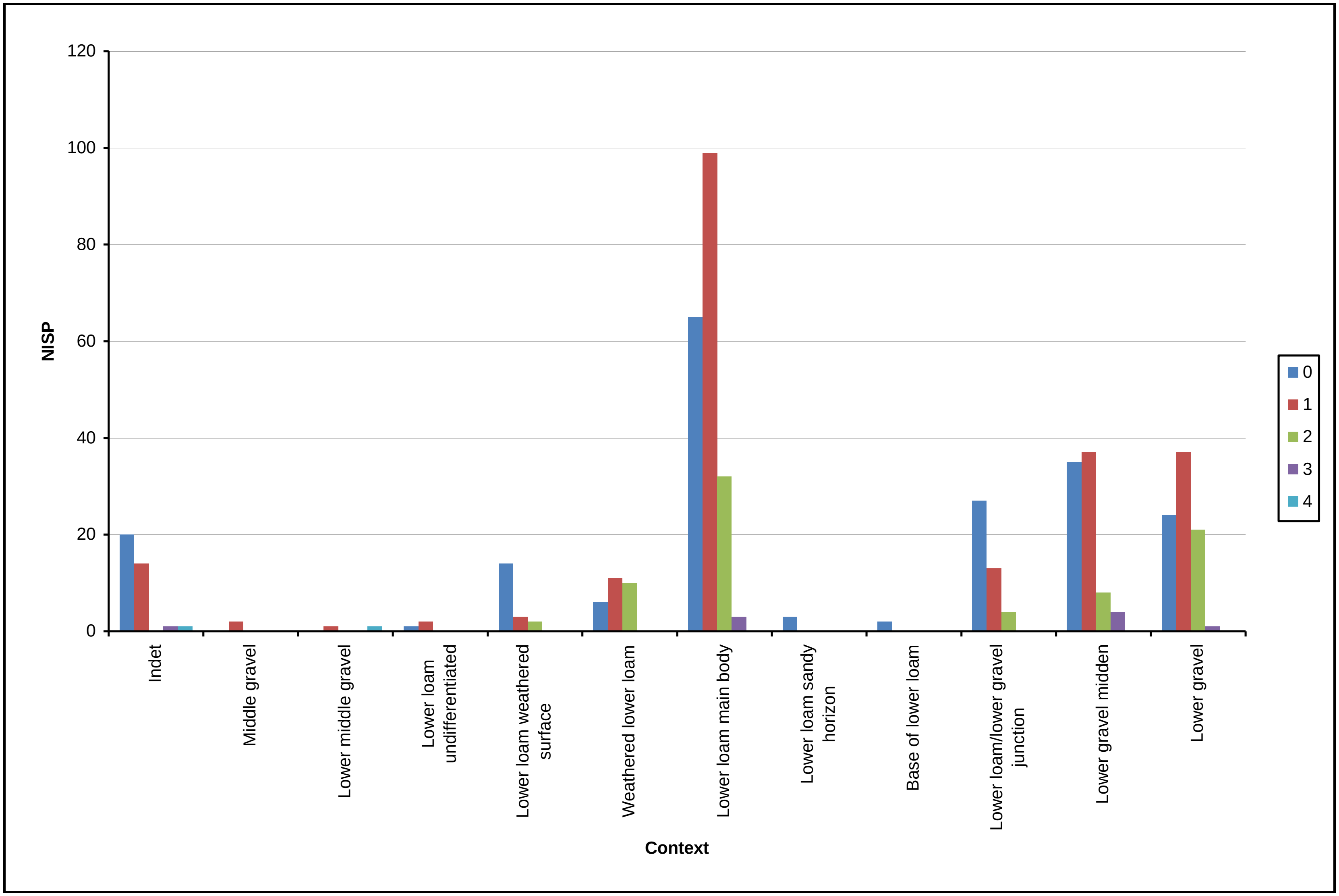

Figure 7.4 Weathering of faunal material throughout the Swanscombe contexts

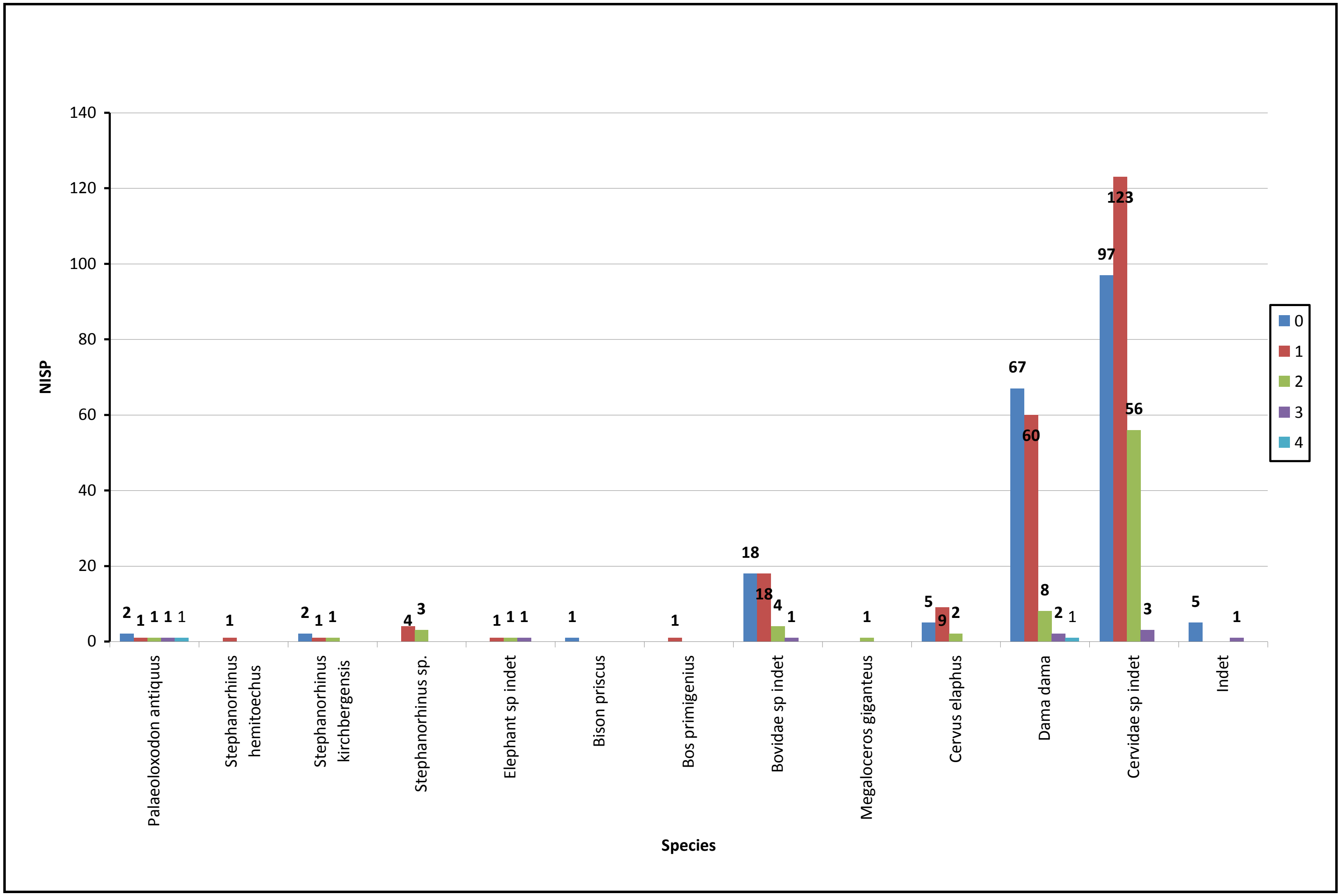

Figure 7.5 Weathering of individual species in the Swanscombe faunal assemblage

Despite the uniformity in weathering, the depth of the deposits at Swanscombe and absence of faunal refitting suggests that the assemblage does not represent a single homogenous accumulation event. Indeed, the variation in the energy of the river regime suggests that faunal material could have been accumulated from numerous sources and transported variable distances before deposition. This suggests the gradual accumulation of material, perhaps from various sources, suggesting a palimpsest deposit rather than a single mass death event (Haynes, 1988b, see later). If the accumulated faunal material remained within the river channel for an extend period of time then this could explain the absence of weathering on the faunal assemblage as the water within the channel could have prevented exposure to sub-aerial processes. Therefore before tackling the role of hominins and other predator-scavengers at this site it is vital to understand the role of natural modification factors in the accumulation and modification of the faunal assemblage

7.3 Other natural modification

Natural modification is recorded across most of the faunal assemblage and on most contexts and species (see Appendix 4 Table 6 and Figure 7.6).

Most of the modification recorded includes cracking (42.4%) and pitting (38.1%) and probably relates to the incorporation of this material into the gravel/river deposits. The presence of scratch marks on these remains also suggests that this material was scratched during incorporation. Additionally, the presence of significant amounts of hydraulic modification (10.5%) throughout all contexts suggests that the river channel had more of an impact on faunal accumulation and modification than previously considered. The heavy degree of rounding observed on some of the fractured specimens indicates submergence in a river environment and perhaps suggests the transport of these faunal specimens over considerable distances (see Figure 7.7). In addition, the limited amount of root etching recorded (2.6%) suggests that the faunal material was exposed in a terrestrial environment for a short period of time, as indicated by the weathering data (see Section 7.2). This analysis of natural modification provides further evidence that the river channel and system had an important role at Swanscombe in the transport, accumulation and modification of the faunal assemblage.

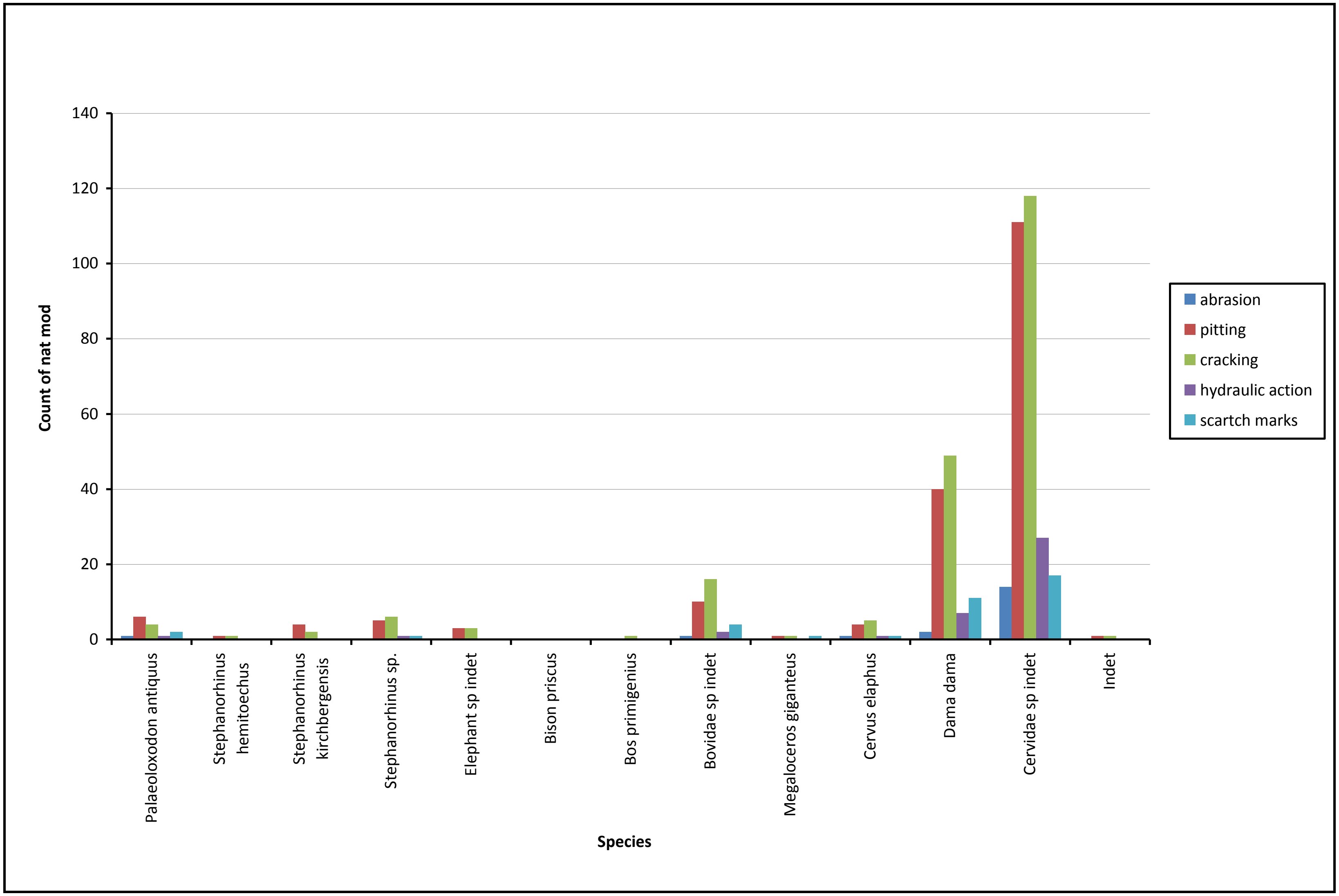

Figure 7.6 Distribution of natural modification across Swanscombe species

The previous analysis suggests that there has been considerable hydraulic modification caused by the river and possibly introducing material accumulated from elsewhere in the river catchment. The uniformity of the weathering data appears to provide supporting evidence that the faunal material was not exposed to significant sub-aerial processes, and suggests that this material remained within the river channel and was subsequently deposited during overbank events as part of a general gravel aggradation. Such evidence suggests that the river system had a more important role in the accumulation, modification and transport of the faunal remains than previously considered. Having highlighted that natural factors appear to have played an major role in the accumulation of faunal assemblage it is now important to consider the extent to which these natural factors were responsible for the accumulation of the faunal remains from each species.

Figure 7.7 Examples of hydraulic modification on numerous faunal specimens
1) SC70 A7 #30 antler base; 2) SC71 B3 antler tine; 3) SC70 A3 #107 humerus; 4) caudal and 5) anterior views of distal humerus SC68 TRA 165 LG

7.4 Cervids

7.4.1 Red deer

The red deer (*Cervus elaphus*) is one of the least common species within the Swanscombe faunal assemblage (NISP= 16; 3.2%), with a dominance of cranial (68.8%) over post cranial (31.3%) remains, though these apparently high figures mask the small nature of the assemblage (see Appendix 4 Table 7). The cranial remains are again unsurprisingly dominated by teeth (NISP= 10; 62.5%). Similarly, antler fragments usually preserve well, and it is interesting that there is a low number of these specimens recorded for red deer (NISP= 1; 6.5%). Specimens identified as red deer have a small Minimum Number of Elements (MNE) when using traditional skeletal elements (MNE= 2; humerus) and this figure is similarly small when using dental pairing (MNE= 2; molar). Such small MNE figures produce a similarly small Minimum Number of Individuals (MNI= 1; based on humerus) and this figure does not increase when using the dental pairing of teeth from this assemblage (MNI=1; molar). The small size of the assemblage has produced fairly consistent numbers when quantified for MNE and MNI values and suggests that the red deer specimens represent at most a single individual. The preservation of large numbers of teeth, denser portions of the appendicular skeleton (humeral and tibial shafts and distal epiphyses) and complete extremities suggests the preservation of denser skeletal elements/portions (see Appendix 4 Table 8). Indeed the absence of body parts from most regions of the skeleton, most notably the axial skeleton and crania, strongly indicates the differential destruction of these elements. The importance of the river at this site as a mode of deposition and modification, together with the absence of predator-scavenger or hominin modification, strongly suggests that these elements were accumulated by the river and that the remaining elements represent a lag deposit perhaps within the low energy environment of a meander cut-off/tufa accumulation (see above).

7.4.2 Fallow deer

Fallow deer (*Dama dama*) are the most common deer species recorded at Swanscombe (NISP= 138; 27.4%) with a dominance of cranial (70%) over post cranial (30%) elements (see Appendix 4 Table 9 and Figure 7.8).

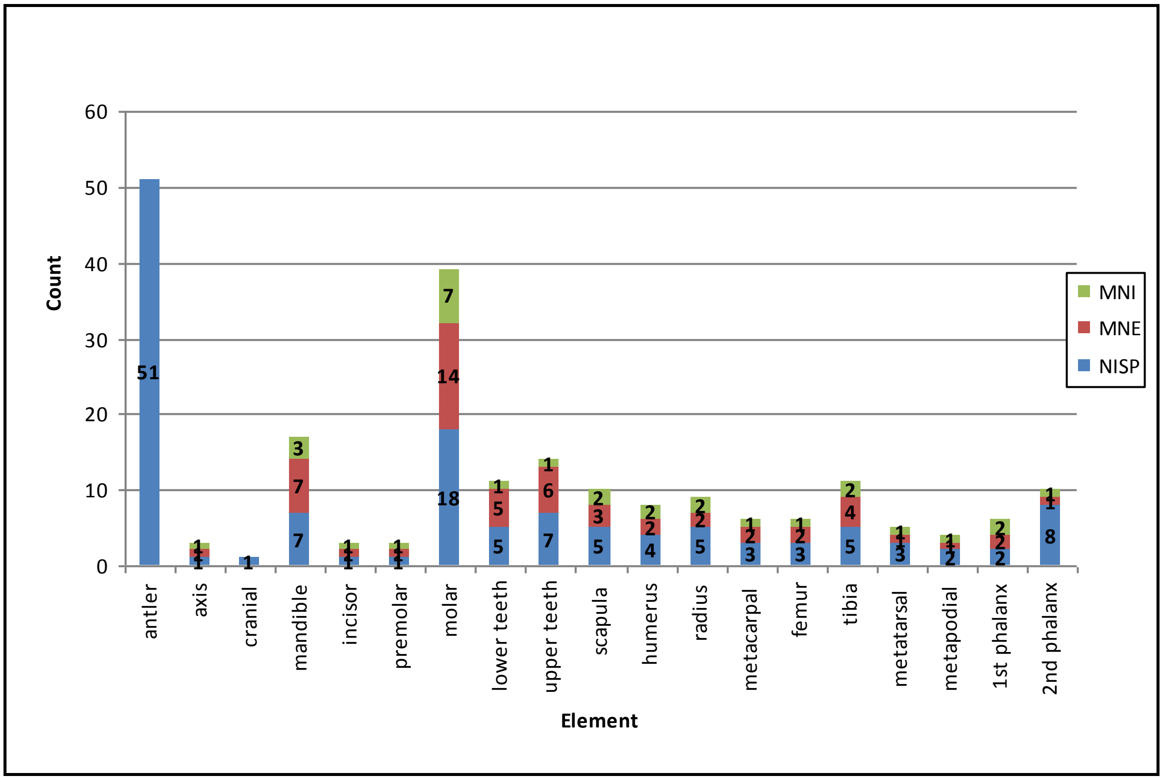

Figure 7.8 Fallow deer NISP, MNE and MNI values

Those specimens assigned to fallow deer have a relatively small MNE when using skeletal elements (MNE= 4 based on tibia) though this figure increases greatly when using dental specimens (MNE= 14 based on molar). The small MNE for post cranial skeletal elements relates to a similarly small number of individuals (MNI= 2 based on tibia) though the MNI is again greatly increased when using dental pairing (MNI= 7 based on molar). The dental pairing MNE suggests the representation of a larger number of individuals but this is not supported by the MNE using the post cranial skeleton and this fact could relate to an increased fragmentation of the post crania related to the destruction/removal of specific elements and bone portions through various taphonomic agents (see below).

Overall it appears that the fallow deer remains have undergone some degree of fragmentation which has reduced the MNE/MNI count. The general fragmentation of the assemblage would appear to suggest that there has been selective preservation of denser cranial and post cranial elements and it is vital to assess the impact that variation in the relative mineral density could have had on the preservation/deletion of specific elements/portions.

Inter and intra element variation in relative mineral density affects their survival and longevity within the archaeological record (Lam *et al.*, 1998; Lam *et al.*, 1999; Lam *et al.*, 2003; Lyman, 1994) and Chapter 3 outlined certain consistencies that cross cut species type (1997). Any study into the affect of relative mineral density on element survival needs to also assess bone surface modification to determine whether modification by nature, predator-scavengers or hominins can help to explain the absence of certain elements/portions. Ultimately, it is necessary to explain the presence of certain elements as much as the absence of others.

By using Stopp's categories as a guide, the fallow deer assemblage exhibits some patterns that suggest the studied assemblage represents, to a degree, evidence of density mediated destruction. The large quantities of antler fragments (NISP= 51; 38.6%) along with both isolated and associated teeth (NISP= 32; 24.2%), account for 63% of the fallow deer assemblage. Similarly, the absence of identifiable cranial vault fragments (NISP= 1) apart from mandibular specimens again suggests the selective removal of weaker bone portions (see Appendix 4 Table 10). The mandible is the most identifiable cranial portion, as well as being one of the densest cranial portion (Lyman, 1994). Despite the small number of specimens involved it appears that the mandible has a relatively high specific density, and could again provide evidence for the differential survival of dense skeletal elements. Thus, evidence from the cranial skeleton also appears to indicate the selective preservation of denser cranial portions. Therefore, it is important to study the survival of other elements and bone portions to see whether a similar pattern of survival can be highlighted throughout the post cranial skeleton.

What is immediately striking about the fallow deer skeletal profile is the complete absence of the axial skeleton (both vertebra and ribs) except for a single, near-complete axis; a pattern observed at some of the other study sites (see Lynford and Hoxne). Although vertebral specimens were recorded within the *Cervidae sp indet* category these were frequently too small to assign to any particular species. The complete absence of the vertebral column from the fallow deer skeletal profile, and the small size of the specimens from the indeterminate category, perhaps suggests the destruction/removal of these elements from the site. The limited amount of non-natural modification (hominin and carnivore) and the evidence for significant natural modification (particularly fluvial) indicate that these portions could have been selectively destroyed and/or removed by the river system at the site.

The appendicular skeletal demonstrates evidence for the fragmentation of some specimens (see Appendix 4 Table 11). The scapula is represented by a relatively small number of specimens (NISP= 5) illustrating some fragmentation (MNE= 3), and a small number of individuals (MNI= 2). A similar pattern is documented in the both the upper and lower portions of the fore limb with a relative large number of specimens (humerus NISP= 4; radius NISP= 5: metacarpal NISP= 3), corresponding to a similarly small number individuals (humerus MNI= 2; radius MNI= 2; metacarpal MNI= 1). Fore limb portion survival is interesting and appears to show some density mediated destruction (see Appendix 4 Table 11), as discussed previously (see Chapter 3 and Stopp, 1997). The scapula is represented by both head and blade fragments though the density of these portions is fairly similar which could explain the absence of variation in the portions preserved (see Appendix 4 Table 12). The humerus is only represented by distal epiphyses which have been demonstrated by several authors to be the densest portion of this element (Binford, 1981; Stopp, 1997). The absence of shaft and proximal epiphyses suggest the differential destruction/removal of these portions from the faunal assemblage also shown by the cranial elements. Similarly, the radius is only represented by proximal epiphyses which, as Stopp (1997) notes, forms a strong joint with the distal humerus (see Appendix 4 Table 11). The absence of carpals is interesting but could reflect either the transport of these small, but dense, elements off site or reflect excavation techniques which were known to focus on larger, more identifiable specimens (Currant, *pers comm.*). The metacarpal has a fairly high density throughout the entire element which could explain the absence of any disparity between the preservation of specific portions. Furthermore, the preservation of complete phalanges, which represent some of the densest skeletal elements, indicates that relative bone density has affected the composition of the fallow deer assemblage.

A similar pattern can also be seen when the hind limb is considered in similar fashion though the pelvis is not present in the assemblage (see Appendix 4 Table 11). The femur is represented by all bone portions and suggests limited density mediated destruction of this element. However, the tibia which has been used as a definitive indicator of assemblage destruction (Binford, 1981) again illustrates a greater representation of denser distal epiphyses compared to proximal epiphyses and shaft. Metatarsals have a similarly high density throughout, and follow a similar pattern to the metacarpals with all portions preserved equally. Such a pattern, combined with the humeral evidence and other post cranial data, suggests the differential destruction of less dense elements and portions from the Swanscombe fallow deer assemblage.

Overall it appears that the fallow deer has undergone significant fragmentation which has reduced the MNE/MNI for the post cranial skeleton, reducing these values compared to the cranial values. The small size of the assemblage, and elements preserved, could account for this perceived fragmentation, although when taken in combination with specific variation within and between elements it appears that density has clearly had a significant impact on assemblage formation and accumulation. The general fragmentation of the assemblage would appear to suggest that there has been selective preservation of denser cranial and post cranial elements. This is most emphatically illustrated by the overabundance of antler and teeth fragments and the absence of cranial vault fragments and almost the entire axial skeleton (Appendix 4 Table 13). Such a pattern can also be observed when analysing, in more detail, the specific preservation of limb bone portions. Binford (1981) has previously noted that the differential preservation of the distal humerus and tibia can be used as an indicator of assemblage destruction, and this certainly appears to be the case for the fallow deer assemblage. The differential preservation of elements and portions combined with an absence of predator-scavenger and hominin modification (see below) perhaps suggests that natural agents were responsible for this differential preservation. The natural modification and weathering data suggests that the river system perhaps had a larger role than previously considered and could easily explain the absence of specific elements/portions through differential transport/destruction.

Predator-scavenger modification

Predator-scavenger modification is limited to puncture marks on the proximal epiphysis of a metatarsal, indicating possible disarticulation and gnawing for marrow (see Figure 7.9). Such modification does not suggest hyaena, as the source, as these animals have the ability to crack the denser shafts. Instead, modification around the epiphysis suggests either wolf (*Canis lupus*) or lion (*Pantherea leo*) both of which are recorded in the assemblage. The absence of predator-scavenger modification suggests that natural factors, particularly fluvial modification, were more important in assemblage formation and modification.

Figure 7.9 Predator-scavenger tooth pit on metatarsal proximal epiphysis (SC71 B3 #77)

Hominin modification

Hominin modification is limited, on fallow deer remains, to an isolated scapula and tibia fragment. Although the modification is limited, the scapula appears to illustrate evidence for an impact point (see Figure 7.10) similar to others identified at other sites such as Boxgrove (See Chapter 5, Parfitt, 1999a; Roberts and Parfitt, 1999a; Smith, 2003b).

Figure 7.10 Fallow deer scapula with possible hominin impact point (SC71 A3 60-80cm)

The tibia exhibits a cut marked distal epiphysis suggesting the disarticulation of this element from the limb extremities (see Figure 7.11). In addition, the deliberate fracturing of the tibia suggests processing for marrow possibly after the disarticulation of the bone.

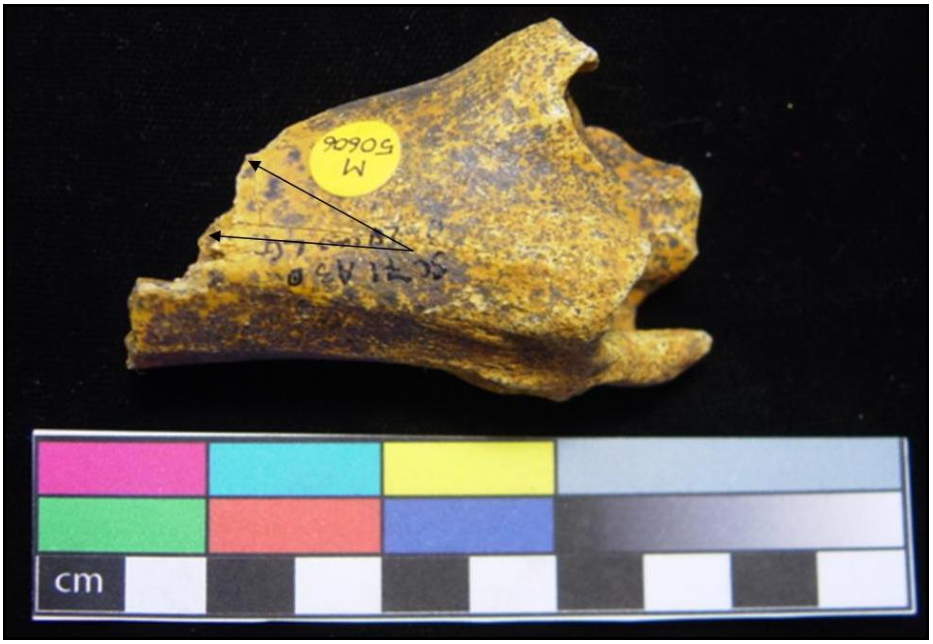

Figure 7.11 Hominin deliberate fracture of fallow deer distal tibia (SC71 A3 0-20cm)

The hominin modification suggests some form of active subsistence within the Swanscombe palaeolandscape. However, isolated modification on a limited number of specimens cannot, and should not, be used to construct more detailed models about hominin resource exploitation. In addition, when considered within the context of site and assemblage formation it would appear unwise to draw definitive conclusions about hominin subsistence within the site locale as the river system appears to have had a more significant affect on assemblage composition than previously considered by other researchers.

7.4.3 Giant deer

Giant deer are only represented by a single distal femur fragment and this small sample size means it is impossible to formulate any accurate conclusions about its genesis.

Predator-scavenger modification

Predator-scavenger gnawing around the distal epiphysis of the femur and the deliberate fracturing of this element highlights modification in order to access the marrow cavity. The location of this modification suggests predators with reduced masticatory ability such as wolf (*Canis* lupus) or lion (*Pantherea leo*).

7.4.4 Cervidae sp. indet

This general category applies to all elements that can be assigned to cervid but not identified to species, and forms the largest category of any species within the Swanscombe faunal assemblage (see Figure 7.12). The assemblage illustrates that a wide range of cranial and post cranial remains are represented with elements from most of the skeletal regions. Unusually, there is a slight dominance of post cranial (52.1%) over cranial (47.9%) elements. The skeletal representation appears to highlight a relatively large number of elements (MNE= 5, based on femur) which corresponds to a relatively high number of individuals (MNI= 4, based on femur). Interestingly, the figures obtained when using dental pairing, on this occasion, provide a smaller number of elements (MNE= 5, based on teeth) and a correspondingly low number of individuals (MNI= 3, based on teeth). Although these quantified figures are the highest of any from the Swanscombe faunal assemblage, it is apparent from the graph that both cranial and post cranial elements have undergone considerable fragmentation (see particularly humerus). It is important to assess whether such fragmentation is also the result of density mediated destruction, and this will be assessed below using Stopp's (1997) previously outlined criteria (see Chapter 3).

It has been documented for all the identifiable cervid species that antler dominates the cranial skeletal preservation (64.8%) and that the high density of this region explains the exceptional preservation. Cranial vault fragments have a higher representation (11.7%) than within any of the other species discussed, but they still exhibit considerable fragmentation when compared to the rest of the cranial and post cranial skeleton, perhaps suggesting destruction through trampling. Teeth are again well represented (23.4%) though there is considerable evidence for fragmentation, particularly on the molars (NISP= 14, MNI= 1), suggesting that these elements have undergone some degree of destruction.

The axial skeleton is represented by elements from the entire length of the vertebral column, unlike other cervid species (Appendix 3 Table 13). Interestingly, the majority of the portions that survive are composed of the denser centurm, with only a few specimens preserving the less dense spinous and transverse processes. This pattern indicates small scale selective destruction of less dense element portions.

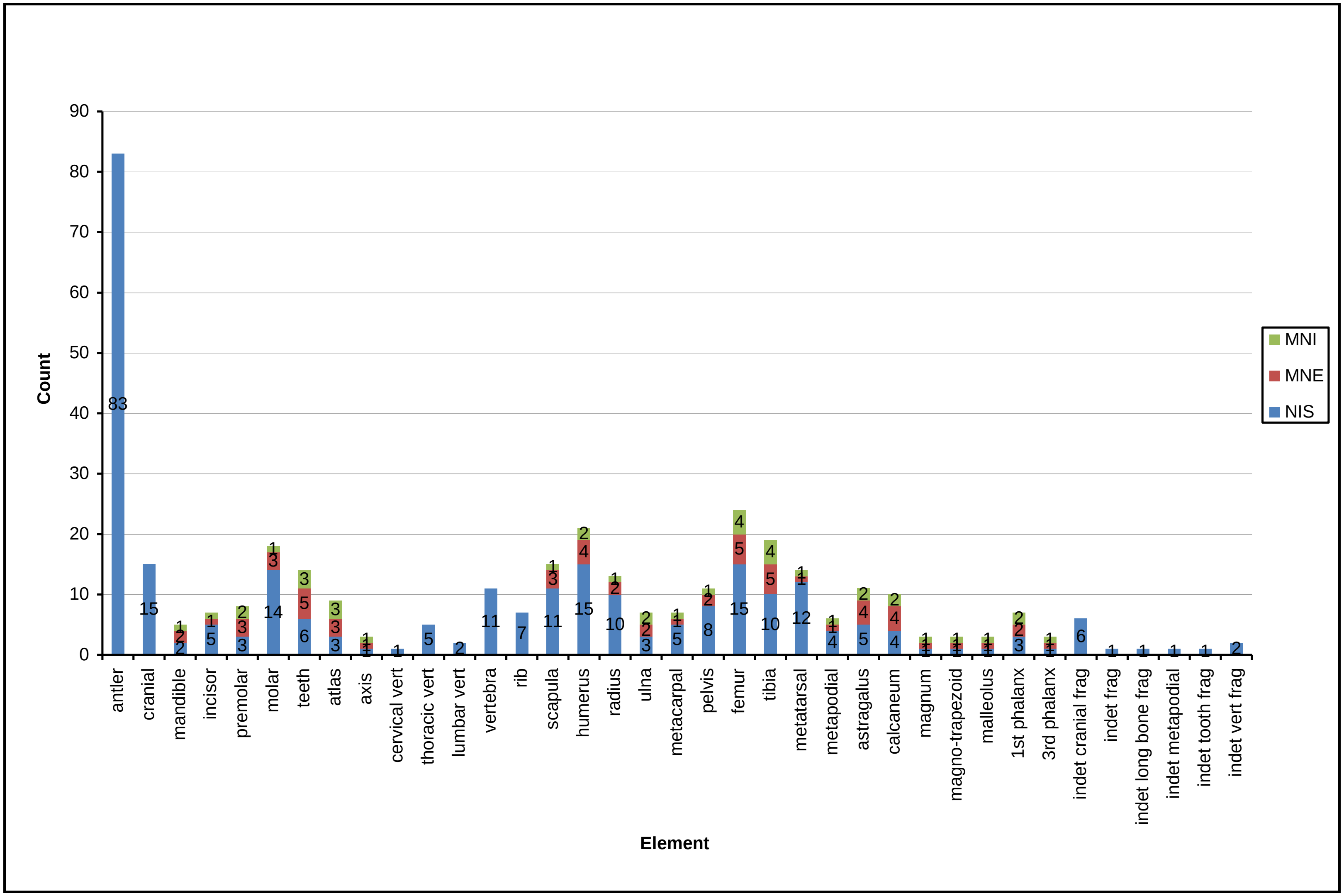

Figure 7.12 Cervidae *sp indet* NISP, MNE and MNI values

A similar pattern can be identified for the appendicular skeleton on both the fore and hind limb. The scapula exhibits considerable fragmentation (NISP= 11, MNI= 1), and the portions surviving are those denser regions of the scapula head and glenoid cavity along with the proximal portion of the scapula blade (see Appendix 4 Table 14) (See Lyman, 1994). A similar pattern of intense fragmentation can be identified on the humerus (NISP= 15, MNI= 2), with a similar disparity in terms of the regions represented (see Appendix 4 Table 15). What is immediately apparent is that the distal epiphyses and shaft along with the mid-shaft region are predominant with some proximal shaft but no proximal epiphyses. Such evidence suggests that there has been the differential destruction of the less dense proximal regions. The radius highlights similar fragmentation (NISP= 10, MNI= 1) though the representation here is dominated by shaft and distal shaft fragments with very few epiphyses.

The hind limb appears to demonstrate a similar level of fragmentation to the fore limb (see Appendix 4 Table 15). The pelvic portions represented are the acetabulum and surrounding bone, which constitute the densest regions of this element, and certainly appear again to suggest the differential destruction of less dense elements prior to or during burial (see Appendix 4 Table 16). Similarly, the femur shows some evidence of fragmentation which appears as intense as that on the forelimb (NISP= 15, MNI= 4). The portion preservation comprises a wide range of surviving regions, primarily dominated by the dense shaft regions. Additionally, there does not appear to be the same distinction between the proximal and distal epiphyses as observed in the humerus. The tibia also illustrates considerable fragmentation (NISP= 10, MNI= 4), though perhaps not as severe as some of the other elements documented above. Portion survival in the tibia appears to highlight that the dense shaft fragments are again prevalent, though there is some differential preservation of distal over proximal epiphyses which could indicate density mediated destruction. The variation between these portions is not as clear and well defined as some elements, most notably the humerus.

The podials and metapodials are extremely well represented in the assemblage, though this is not necessarily surprising as these are some of the densest elements in the skeleton. Indeed the metapodials demonstrate fragmentation as severe as that for the upper limb bones, but the similarity in density for these elements does not allow for a discussion into the differential destruction of element portions (see Appendix 4 Table 15). The preservation of complete or near complete podials attests to the durability of these small bones and is perhaps some of the clearest evidence for the presence of a density mediated faunal assemblage.

The indeterminate cervid bones demonstrate the preservation of a wide range of skeletal elements which have often been severely fragmented and show some evidence for the density mediated destruction of specific portions. It is possible that this has been caused by the fluvial action, which appears to have influenced the accumulation and composition of other species at this site. However, there is evidence for both predator-scavenger modification and hominin modification and these mechanisms also need to be considered as agents of accumulation and fragmentation.

Predator-scavenger modification

Predator-scavenger modification is recorded on several elements from the post cranial skeleton though no modification has been recorded on cranial elements (see Figure 7.13). A predator puncture mark on the atlas illustrates sustained dental contact and disarticulation of the vertebral column to access the spinal cord or the removal of the skull from the axial skeleton (Figure 7.14). Most of the modification relates to marrow-processing on the long bones and is confined to the epiphyses of the humerus, femur, radius and phalanx (see Figure 7.15 and Figure 7.16). Some of these specimens exhibit severe crenelation around the epiphysis highlighting prolonged dental contact and the extraction of marrow from the cavity. The location of this modification suggests a predator without the masticatory ability of the hyaena which can crack limb shafts, probably either a wolf (*Canis lupus*) or lion (*Pantherea leo*) both of which are recorded at the site. Evidence for marrow-processing suggests secondary access to carcasses once the meat and muscle has been removed from the bones and perhaps indicates that these carcasses have been scavenged around the river margins, possibly from natural deaths.

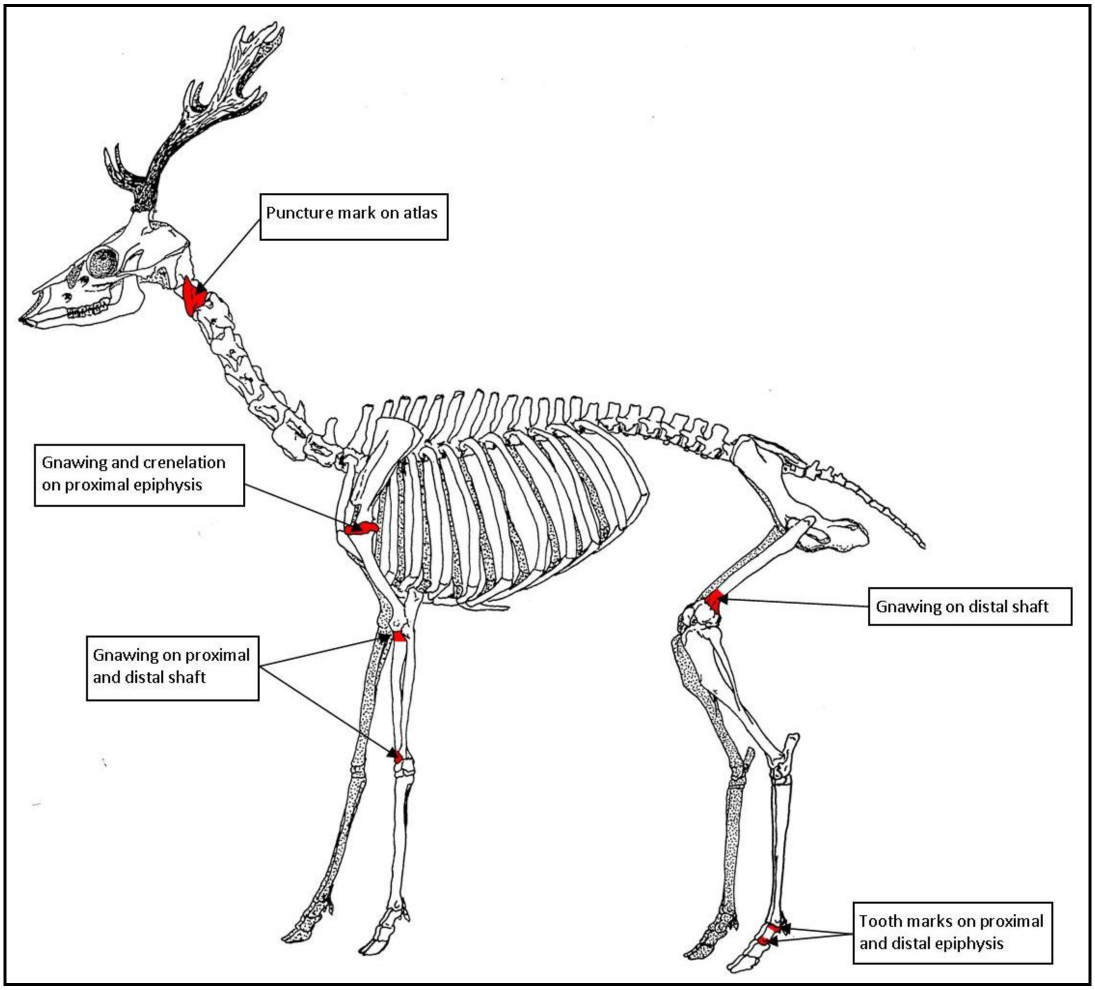

Figure 7.13 Distribution of predator-scavenger modification across cervid sp. indet skeleton Modified from Chapman and Chapman (1975; Figure 1)

Figure 7.14 Predator-scavenger puncture point on cervid sp. indet atlas (SC70 B2 #23)

Figure 7.15 Predator-scavenger crenelation on cervid sp. indet proximal epiphysis of humerus (SC71 B3#33)

Figure 7.16 Predator-scavenger tooth pits on cervid sp. indet phalanx (SC71 B2)

Hominin modification

Cut marks on the foramen magnum and atlas indicate that the skull was disarticulated and removed from the vertebral column, which suggests a relatively complete carcass (see Figure 7.17). Similar cut marks on the palate surface may relate to the removal of the tongue, presumably once the head had been removed. Cut marks on the humerus indicate prime access to meat from this region and certainly suggest that hominins were exploiting these individuals prior to other predator-scavengers. However, it is still unclear whether these communities were active agents of carcass accumulation or whether they chanced upon the carcass of animals that had died naturally at this locale. The evidence of heavy fragmentation and density dependent bone survival places severe limits on the confidence we can attribute to using this assemblage as direct evidence of a 'cultural accumulation'.

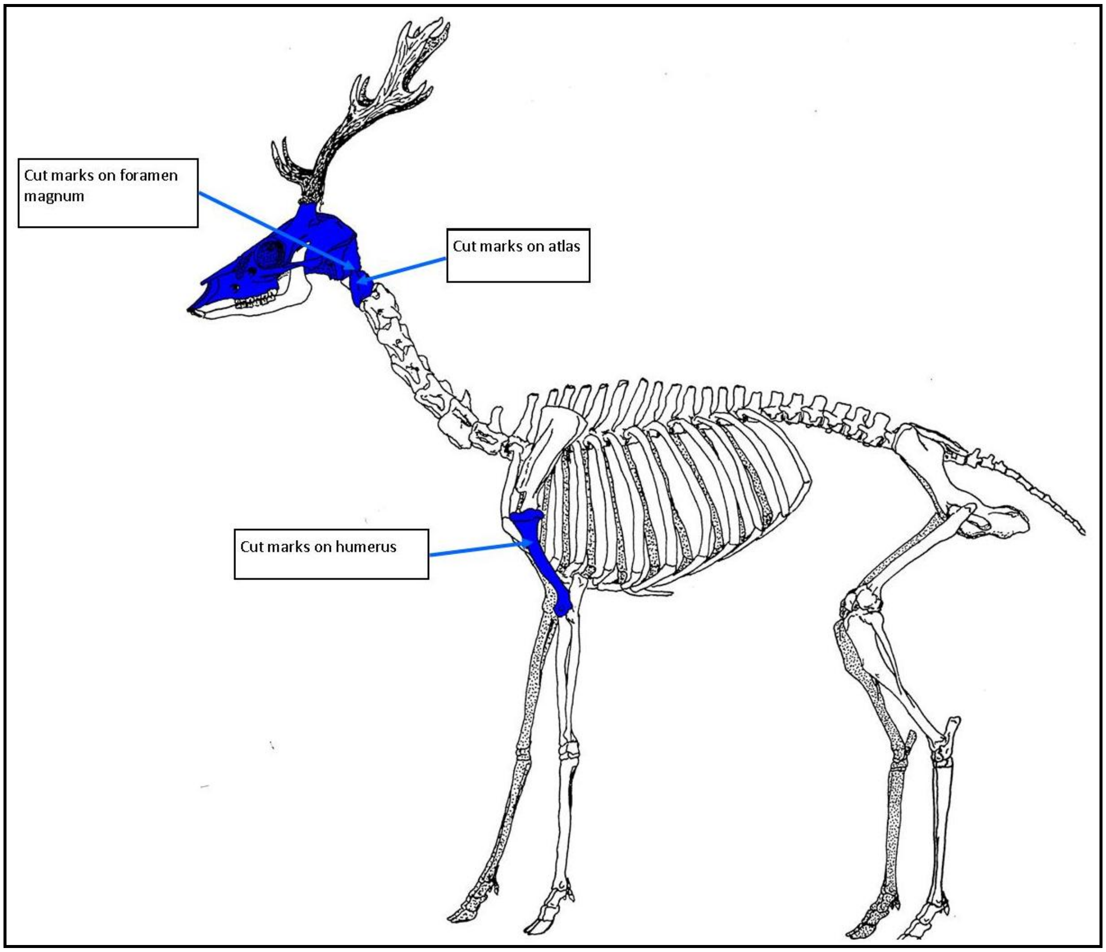

Figure 7.17 Distribution of hominin modification across cervid sp. indet skeleton
Modified from Chapman and Chapman (1975)

7.5 Bovids

7.5.1 Wild cow

Wild cattle (*Bos primigenius*) are represented by a single metatarsal comprising the distal epiphysis and distal shaft. These are dense elements that survive well at most sites, though again interpretation or discussion of assemblage formation is limited by the small sample size.

Predator-scavenger modification

Predator puncture marks on the distal epiphysis highlight sustained dental contact and suggest disarticulation of the extremities possibly for marrow exploitation (see Figure

7.18). The location and type of the modification is similar to wolf modification highlighted by Haynes (1980) and certainly suggests a carnivore such as wolf and lion.

Figure 7.18 Predator-scavenger tooth pit on metatarsal distal epiphysis (SC71 B2 0-20)

7.5.2 Bison

Bison (*Bison priscus*) are represented by a single isolated horncore fragment perhaps suggesting a natural accumulation though it is impossible to come to definitive conclusions about the formation of the assemblage.

7.5.3 Bovidae sp. indet

This category includes material identified as bovid but could not be assigned to a particular species, and this group has more specimens than either of the identifiable bovid species at this site (see Appendix 4 Table 17 and Figure 7.19).

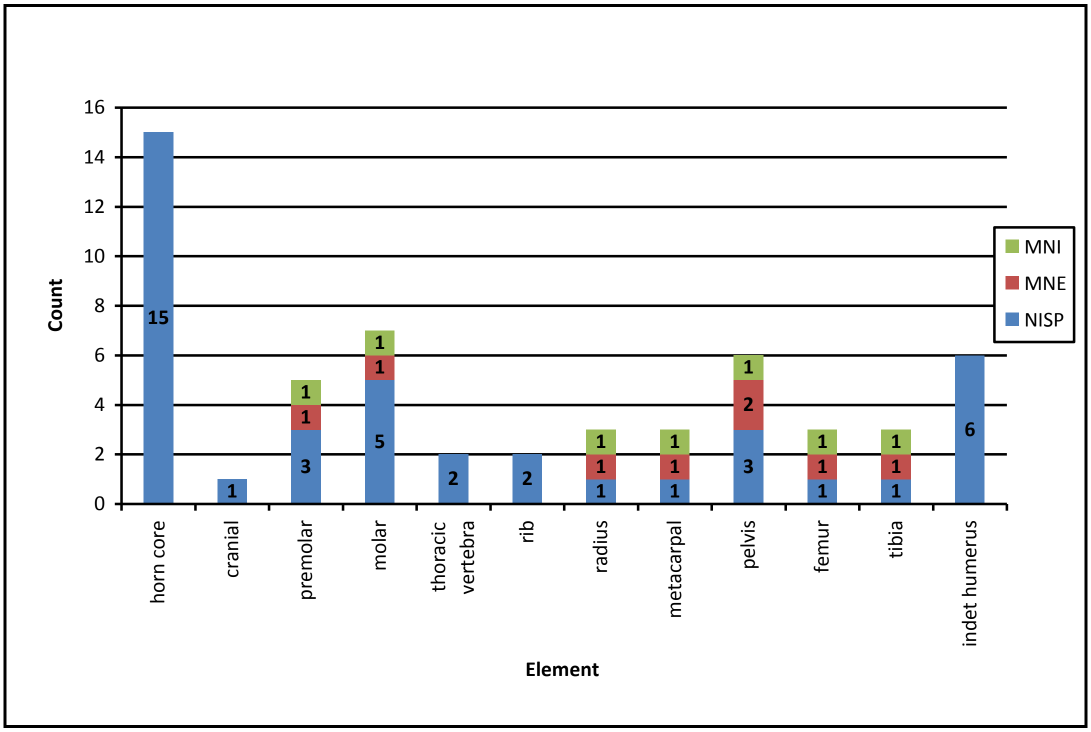

Figure 7.19 Bovid sp. indet NISP, MNE and MNI values

The assemblage is dominated by horn cores (NISP= 15) and tooth fragments (NISP= 8), with very few cranial vault specimens surviving (NISP= 1). This pattern appears to support that identified for other species with more dense horn core and teeth surviving, whilst less dense regions such as the cranial vault are more easily destroyed and removed off site. Perhaps then it is unexpected to see vertebra recorded in the assemblage but closer inspection shows that the portion most represented is the denser centrum. As previously highlighted, vertebral processes are susceptible to destruction, which could explain the absence of other vertebral portions (see Chapter 3). A single rib specimen is represented, with the surviving mid-shaft portion representing, according to Lyman's (1994) data, one of the densest regions of that element.

The body part representation of the appendicular skeleton consists of shaft fragments (indet humerus NISP= 6; radius NISP= 1), which again indicate density mediated survival (see Appendix 4 Table 18), likewise with the preservation of a proximal metacarpal. Similarly the pelvis is represented by the dense acetabulum and the denser surrounding bone. The presence of an associated femur head with one of the pelvic fragments perhaps suggests that these elements were not sufficiently disturbed or disarticulated during burial in order for them to be recovered in association (see below). Similarly the tibia is represented solely by a dense shaft fragment again strongly suggesting differential preservation.

Hominin modification

No predator-scavenger modification was recorded on the bovid material although there was evidence for a single cut mark on the femur head associated with the pelvic acetabulum (see Figure 7.20 and Figure 7.21). Such modification suggests disarticulation of the femur from the pelvis and suggests primary access to the nutrients on this element. The absence of predator-scavenger modification perhaps suggests that hominins had more primary access to resources on some elements. The fact that the pelvis and femur were refitted provides tantalising evidence of areas where it is possible to identify relatively *in situ* behavioural episodes at Swanscombe. Nevertheless, one cut marked bone is not sufficient evidence to discuss subsistence strategies, and this evidence must be treated with caution but certainly illustrate that hominins were present in the surrounding locale and modifying the faunal material.

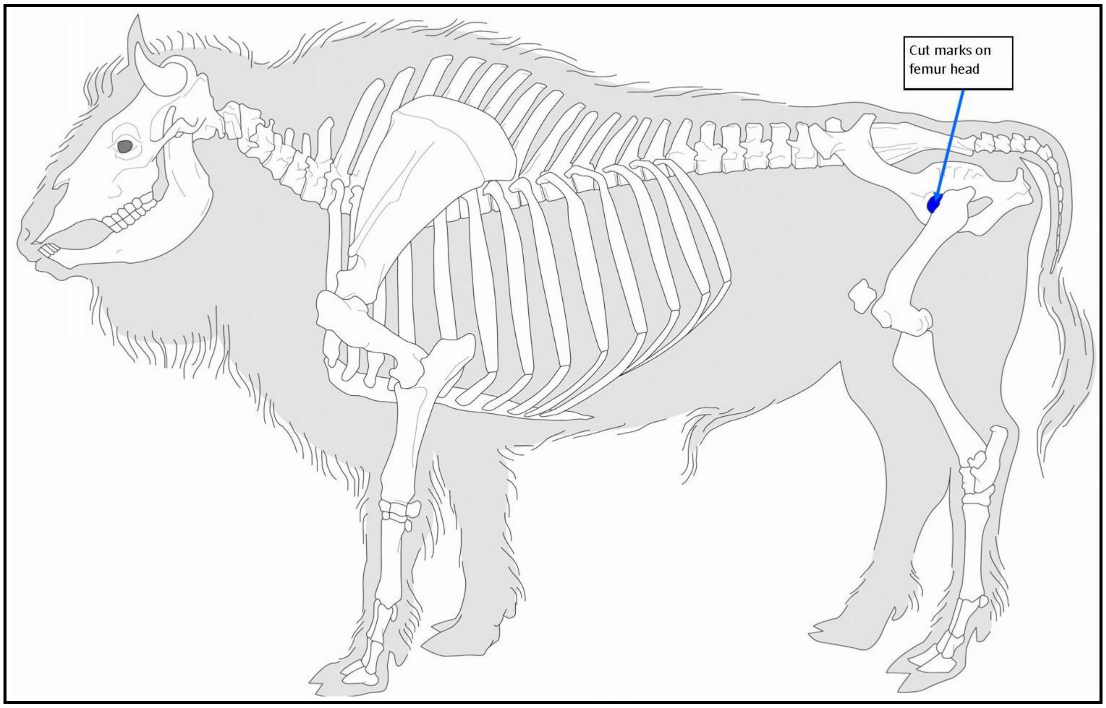

Figure 7.20 Distribution of hominin modification on bovid skeleton
Skeletal outline modified from Yvinec *et al* ((2007)

Figure 7.21 Bovid sp. indet femur head with hominin cut mark (A2 #99)

7.6 Megafauna

7.6.1 Elephant (includes Elephant sp. indet)

The straight tusked elephant (*Palaeoloxodon antiquus*) is the largest species recorded at Swanscombe and the best represented of all the megafauna (NISP= 8; 1.2%) (see Appendix 4 Table 19). Specimens are recorded from both cranial and post cranial skeleton, though there does not appear to be a dominance of either. The evidence for fragmentation is limited, suggesting a small number of individuals using traditional skeletal quantification and dental pairing (MNI= 1, based on pelvis or molar). The cranial elements are composed of an isolated occipital fragment, the tooth row and diastema of a mandible and an isolated, but complete, molar. The survival of cranial elements is comparatively poor when compared to some of the other megafauna (see 7.7.2), and the absence of other cranial portions indicates considerable fragmentation and removal of these elements. Although post cranial elements are represented, the absence of most of the post cranial skeleton also suggests that these elements have been transported away from site. The elements that have been preserved are an unusual mixture, composed of two rib shafts, two pelvis specimens and a relatively complete calcaneum. Although ribs are often perceived as relatively weak elements, the size and density of elephant ribs could be considerably greater than medium-sized species which are most frequently used in discussions of bone density. Such exceptional preservation has been highlighted at other study sites (see particularly Chapter 6) and could explain why these elements are relatively whole. The pelvic portions surviving are generally those denser regions including the acetabulum and the surrounding bone, perhaps indicating fragmentation and removal of these elements prior to burial.

Interestingly, elephant remains indicate a high degree of natural modification and weathering which suggests that some of these elements have been exposed to terrestrial process for a considerable time period. There is evidence for predator-scavenger modification (see below) but no hominin modification. There is evidence for some bone remodelling on a rib shaft and this has been suggested as evidence for failed hominin hunting (Schreve, 2006, in press) though it is difficult to be certain that such an injury was not the result of a natural behaviour (see Haynes, 1987, 1988a, 1988b; Smith, unpublished).

Predator-scavenger modification

The calcaneum demonstrates evidence for carnivore gnawing across the entire element, indicating sustained dental contact, possibly representing disarticulation of the extremities from the limb bones (see Figure 7.22 and Figure 7.23). Thus it could be seen as an attempt to access the marrow cavity of the tibia, but the species of predator cannot be determined from such limited modification.

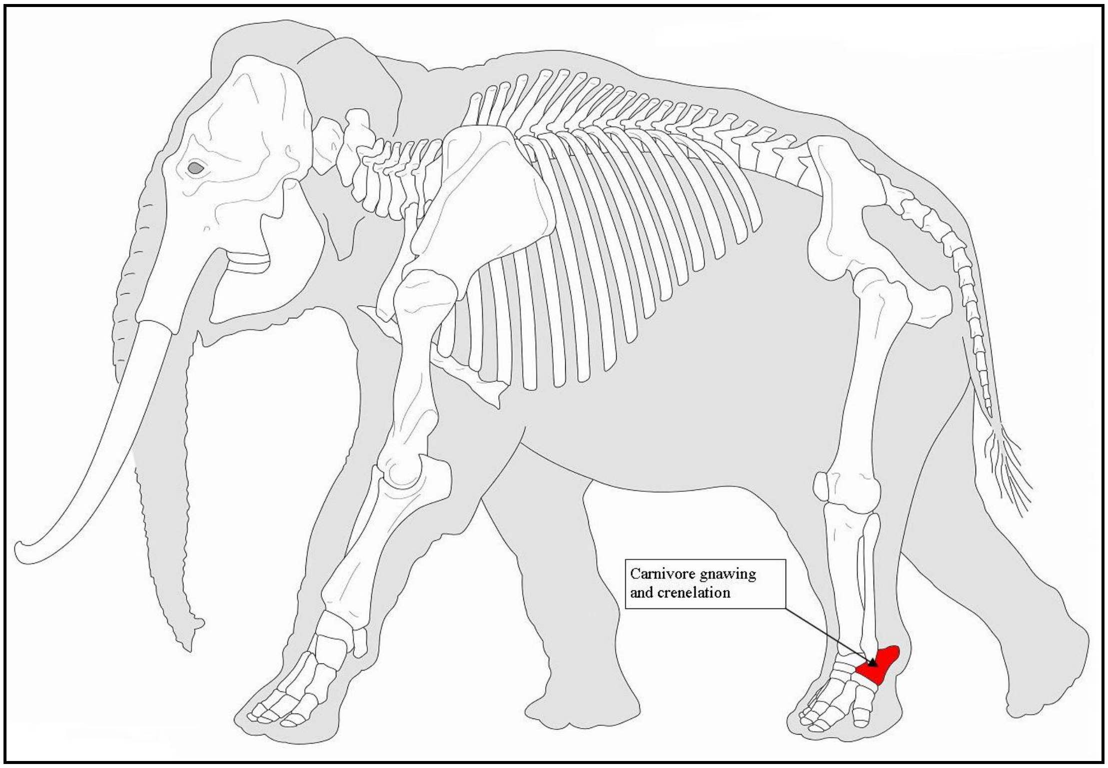

Figure 7.22 Distribution of predator-scavenger modification across elephant skeleton Skeletal outline modified from Yvinec *et al* (2007)

Elephant skeletal remains indicate the representation of a single individual though the absence of a large amount of the skeleton suggests that significant destruction, fragmentation and removal occurred. There is some evidence for density mediated destruction, though the size and density of elephant elements may be considerably different to medium-sized species. The absence of usable data is not ideal and prevents any definitive study into the affects of density on bone survival. Clearly, there is an absence of elements, though the lack of hominin modification and the high quantity of natural modification suggests perhaps that this animal represents a natural death at the site which has subsequently been fragmented through trampling and/or other natural agents (e.g. predator-scavengers) with portions being transported off site by the river.

Figure 7.23 Elephant calcaneum exhibiting extensive predator-scavenger gnawing

7.6.2 Stephanorhinus hemitoechus

This narrow-nosed rhinoceros (*Stephanorhinus hemitoechus*) is represented by a relatively complete cranial vault that only lacks the palate and teeth, and an isolated but relatively complete upper molar (see Appendix 4 Table 20). The preservation and completeness of the skull is, by the standards of the Swanscombe faunal assemblage, exceptional, considering the element was recovered from the Lower Gravel. Although generally the skull is one of the weakest elements in the entire skeleton, the skull of an animal the size of a rhino could have been more compact and thus survived as a more complete specimen. Nevertheless, the small assemblage cannot provide any detailed information about site formation, although the absence of predator-scavenger and hominin modification suggests that these elements represented a faunal accumulation that resulted from the natural deaths of these animals alongside the river channel. This distribution raises further issues about the absence of the other skeletal elements, though their absence might result from destruction by trampling around the river channel or possibly differential transport off-site either through natural agents (e.g. river, predator-scavenger) or by hominins. However, the lack of evidence prevents any more detailed models or analysis of the formation processes that have affected these faunal remains.

7.6.3 *Stephanorhinus kirchbergensis*

The size of the Merck’s rhinoceros (*Stephanorhinus kirchbergensis*) assemblage is as small as that of the narrow nosed rhino (see above) and represented by an isolated upper molar, cranial fragment, carpal and metacarpal, providing a correspondingly small number of individuals (MNI= 1, based on metacarpal) (see Appendix 4 Table 21). As with the other megafaunal species, the small assemblage size limits discussion about site and assemnblage formation (see Section 7.6.2).

7.6.4 Stephanorhinus sp.

This category was for specimens that could be identified as rhinoceros but could not be assigned to a specific species and has a similarly small assemblage (NISP= 7; 1.4%). The cranial skeleton is composed of isolated fragments of the cranial vault, mandible and an individual tooth (see Appendix 4 Table 22). Similarly, there is a notable absence of material from the post cranial skeleton with only a humeral proximal epiphysis and two complete 2nd phalanges. Overall the size of this assemblage is too small to help discuss issues of site and assemblage formation.

7.7 Indeterminate Species

Only six indeterminate specimens were recorded in this category and as such are of little value in attempting to understand faunal assemblage accumulation.

7.8 Assemblage fracture patterns

Considerable fracturing has been identified throughout the assemblage but only on cervid species, and experimental studies have shown that numerous agents can produce similar fracture patterns (Bonnichsen and Sorg, 1989; Brain, 1981; Smith, 2003b). Bone will tend to fracture along the weakest point, usually between the individual osteons, and follow the morphology of the bone though this is dependent upon the freshness of the element. Spiral fractures on long bones usually indicate a fresh ‘green bone’ break whilst saw toothed fracturing is usually more indicative of a break on elements that were older and perhaps more brittle.

The majority of the fractures identified on the Swanscombe faunal assemblage are spiral and, apart from a single fractured antler, are distributed across the post cranial skeleton (see Table 7.2). Some of the long bone fractures identified can be attributed to a specific agent though these are limited. Once these fractures have been removed it is clear that spiral fractures (42.9%) are slightly more common than saw toothed (33.3%), and irregular perpendicular fractures (23.8%), suggesting that some of the fracturing occurred whilst the bone was still relatively fresh. The large numbers of these fractures might reflect the natural trampling of these elements by other animals around the edge of the river channel. The absence of rounding on fracture edges suggests that the faunal material was not exposed to a significant period of hydraulic action perhaps suggesting accumulation within a slow moving river environment or re-exposure on the land surface. Saw toothed fractures indicate that the bones were not deposited as a homogenous assemblage, such as that from a mass death event, and suggests continued re-exposure of elements possibly during times of reduced river flow or flooding.

Species	Element	Fracture type	Modification	Fracture edge
cervidae sp. indet	antler	saw toothed		rough
	scapula	irregular perpendicular		rough
	humerus	irregular perpendicular		rough
	radius	spiral		rough
	radius	saw toothed		rough
	metacarpal	spiral		rounded
	femur	spiral	yes	rough
	tibia	spiral		rounded
cervus elaphus	humerus	spiral		rounded
	tibia	saw toothed		rough
	metatarasal	saw toothed		rough
dama dama	humerus	spiral		rounded
	metacarpal	saw toothed		rough
	metacarpal	irregular perpendicular		rough
	femur	spiral		rough
	femur	spiral		rough
	femur	saw toothed		rough
	tibia	spiral	yes	rough
	tibia	spiral		rough
	tibia	spiral		rounded
	metatarsal	saw toothed		rough
Megaloceros giganteus	femur	saw toothed	yes	rough

Table 7.2 Assemblage fracture patterns

The fracture patterns are not as conclusive as evidence from other study sites (see particularly Lynford) which have highlighted repeated return and re-use of carcass resources, particularly bone marrow, by hominin and other predator species. The fracture patterns from Swanscombe appear to suggest considerable trampling around the edge of the river channel when the material was relatively fresh. The incorporation of faunal material into the channel may have protected it from both terrestrial weathering and further natural modification. However, the relatively large quantities of ‘old-bone’ breaks indicates that material could have been re-exposed; possibly, during changes in flow regime (see above) or during times of floods as indicated by the overbank deposits.

7.9 Discussion

The site of Swanscombe is one of the best known and most studied UK Lower Palaeolithic sites. The sedimentary sequence preserved within this post-Anglian river channel illustrates fluctuations between high and low energy flow regimes, as indicated by the deposition of gravel and silt sediments. Faunal material has been found throughout the stratigraphic sequence, though the majority has been recovered from the Lower Gravel and Lower Loam deposits. The depth of the sedimentary sequence (12-15m) does not provide the same spatial and temporal association that has been recorded from other Lower Palaeolithic sites such as Boxgrove.

The general weathering of the faunal assemblage highlights a relatively uniform pattern. The majority of material is unweathered or exhibiting limited weathering patterns, which suggests a limited period of exposure prior to burial. The lack of heavily weathered specimens suggests that the material has not been differentially weathered or re-exposed. A detailed analysis of weathering within and between contexts appears to illustrate a similar pattern of little to no weathering indicative of rapid burial. The lack of variation in the weathering of the faunal assemblage is interesting. It is possible that accumulated faunal material remained within the river channel for an extend period of time which could explain the absence of high levels of weathering on the faunal assemblage as the water could have prevented exposure to sub-aerial processes.

Natural modification has been recorded across the entire faunal assemblage with most relating to the incorporation of material into the sedimentary units as highlighted by the large quantity of pitting, cracking and scratch marks. Hydraulic modification, in the form of fragment rounding, and pitting related to the bombardment of specimens by the river’s load, suggests a prolonged exposure within the channel. Indeed, the absence of significant root etching combined with the weathering evidence suggests that material was not exposed to terrestrial processes for a long period of time prior to burial. Indeed it is possible that the river had transported material considerable distances from within its catchment area before depositing the material during flood events.

A detailed study of the skeletal representation for all species recorded at Swanscombe highlights, in most cases, significant fragmentation and differential destruction. However, for some species the assemblages were too small to allow for an assessment. The cervid and bovid body part representation for these species was frequently dominated by dense elements such as antler/horncore and teeth. Most of the skeletal part profiles demonstrated considerable fragmentation, often with the destruction of weaker bone portions such as long bone proximal epiphyses and vertebral processes (Binford, 1981). Assemblage fragmentation combined with the natural modification and absence of terrestrial weathering suggests that the faunal material from the Lower Gravel demonstrates evidence for considerable fluvial winnowing whilst material in the Lower Loam could represent a lag deposit within a meander cut off.

Similarly, Ashton and McNabb (1996) have highlighted that although hominin lithics and fauna are found throughout all deposits, the condition and composition of the assemblage indicates that all of the material is derived and moved by fluvial action. Lithic material recovered from the gravel horizons is more heavily abraded from prolonged exposure within a hydraulic environment. However, the material from the Lower Loam is less heavily abraded indicating a slower hydraulic environment during deposition. Combining the lithic data with the faunal remains (see above) suggests that the material from the gravel deposits at Swanscombe represents a more derived assemblage that has perhaps accumulated naturally as a result of river transport and deposition. Conversely, the refitting of some specimens from the Lower Loam, limited abrasion, and evidence for non-human footprints indicates a less disturbed assemblage. However, both my faunal analysis and Stopp's (1997) experimental data indicate that even at low velocities rivers can have a dramatic effect on the composition of a faunal assemblage (Coard, 1999; Coard and Dennell, 1995). The presence of footprints preserved in the loam attests to the movement of animal populations across these deposits and supports the notion of fragmentation by animals trampling. The limited evidence for predator-scavenger or hominin bone surface modification and the intensity of other natural modifications (e.g. hydraulic action), even within the Lower Loam (see below), suggests that the Swanscombe faunal assemblage has undergone significant fluvial modification.

7.9.1 Role of predator-scavengers and hominins

The recovery of large quantities of lithic tools throughout the Swanscombe sequence provides evidence for a hominin presence around the site. The previous discussion, above, has highlighted significant fluvial winnowing within the Lower Gravel and the possible presence of a lag deposit in the Lower Loam. It is apparent that the faunal assemblage is neither a primary accumulation nor solely a cultural accumulation as has been discussed by previous authors (Binford, 1985; Waechter, 1968, 1969, 1976). Therefore, it is important to state that the accumulating role of predator-scavengers and hominins at Swanscombe is more limited than previously thought.

Predator-scavenger and hominin modification was recorded across the Swancombe fauna though the amount is limited (3%) and certainly nowhere near the figure seen at Boxgrove (20%); carnivore modification (1.8%) is more prevalent than hominin modification (1.2%). Predator-scavenger modification was recorded on several species with most modification recorded around limb bone epiphyses. The type and location of this modification appears to suggest a smaller carnivore, possibly a wolf, and illustrates the processing of limb bones for marrow. Identification of puncture marks and teeth marks on the atlas could indicate the detachment of the skull from the vertebral column, possibly indicating primary access to that individual. The majority of predator-scavenger modification concerns the processing of long bones for marrow which would appear to suggest that these animals were mainly scavenging elements already present on site.

Hominin modification is even more limited in scope than predator-scavenger modification, and perhaps provides some tantalising evidence of hominin resource exploitation. There is evidence for the disarticulation of the skull from the vertebral column as well as the disarticulation of the hip joint. Both of these suggest that hominins had primary access to some of the carcasses, and the presence of a possible impact fracture perhaps suggests a more active subsistence strategy. In addition, cut marks on the humeral shaft indicate prime access to meat from that region and further support the idea of a more active hunting behaviour. Other evidence of hominin modification includes the deliberate fracturing of the tibia to extract marrow and cut marks on the palate suggest the removal of the tongue. Although most of the evidence for hominin modification indicates an active strategy, the quantity of modification compared to other non-cultural agents argues against a wholly cultural origin for the faunal assemblage.

Previous authors have used the Swanscombe faunal assemblage to illustrate evidence for hominin accumulation and subsistence. Waechter argued (1968; 1969; 1976), primarily on the ‘association’ of lithics and fauna, for a cultural accumulation indicative of hominin hunting of large-medium sized mammals. In contrast, Binford (1985) demonstrated that hominin modification was mainly distributed on distal extremities which to him suggested a more passive scavenging strategy, though he only studied a handful of specimens. The evidence presented here and above does not support either of these interpretations. Although there is evidence for some ‘active’ hominin modification, the depth and coarse grained nature of the fluvial deposits along with fluvial winnowing and fragmentation does not permit the identification and analysis of specific ‘subsistence events’ or strategies as documented at Boxgrove. Certainly, the footprint horizon identified within the Lower Loam indicates that the river was at a much reduced level allowing for the passage of animals, including hominins, through the landscape (Ashton *et al.*, 2006; Davis, 1996). It is possible therefore that Swanscombe represents a feed locale within the landscape where hominins and other predators could intercept prey and scavenge from natural deaths around the river channel. Nevertheless it is apparent that the river system has played an important role in the accumulation of faunal material at Swanscombe in terms of accumulation, modification and transport.

Chapter 8 Hoxne analysis and results

8.1 Species specific preservation and modification

The faunal assemblage analysed for Hoxne was comprised a total of 492 specimens of which 447 were identifiable to species, representing the smallest assemblage studied for this research project. The assemblage is composed of similar species to those identified in assemblages from Boxgrove and Swanscombe (see Chapter 5 and 7), thus clearly representing an interglacial fauna. Horse (*Equus ferus*) [NISP= 254; 51.6%] and red deer (*Cervus elaphus*) [NISP= 83; 16.9%] are the dominant species, although other species such as giant deer (NISP= 33) and fallow deer (NISP= 2) were present in smaller numbers (see Appendix 5 Table 1 and Figure 8.1). The megafaunal species include an indeterminate elephant and, more frequently, the remains of the extinct rhinoceros *Dicerorhinus* (NISP= 65). Some bone specimens could not be assigned to a certain species (see Appendix 5 Table 1 and Figure 8.1), though these comprised a relatively small percentage of the total faunal assemblage (NISP= 30; 6.1%).

Faunal material was recovered throughout the stratigraphic sequence (see Chapter 4 and Figure 8.2 and Figure 8.3; Appendix 5 Table 2 and 3), with the majority of specimens from Beds 1-4. These beds were initially described as fluvial sediments, representing fluctuating stream discharge into the a small lake (see Chapter 4 and Gladfelter, 1993), although re-analysis has identified that these beds were actually deposited in a channel that was incised into the surface of Stratum C, and re-designated Stratum B2 and B1 (Ashton *et al.*, 2008; Gladfelter, 1993). It is clear, therefore, that most of the faunal material was deposited during the termination of the lacustrine environment and during the early stages of channel incision and deposition of fluvial sediments. The change in flow regime, from lacustrine to fluvial, might suggest that faunal specimens were transported to and removed from the site (see particularly Chapter 7 and Coard, 1999; Coard and Dennell, 1995; Fernadez-Jalvo and Andrews, 2003). Reanalysis of the faunal material has highlighted long-axis alignment in the direction of channel flow (Parfitt, *pers comm.*), providing some of the clearest evidence for a previously unrecognised fluvial impact on the faunal assemblage. Despite evidence for long-axis alignment to the direction of channel flow, limited evidence of hydraulic modification and rounding on the faunal specimens was found (0.61%). Such a low amount of fluvial modification probably demonstrates that the material was not exposed in the main channel but had accumulated on the margins, thus explaining the absence of fluvial rounding or other hydraulic modification. Indeed, it is possible that the long-axis orientation occurred during periods of increased discharge, which subsequently incorporated material from the channel margins.

The faunal assemblage recovered from the fluvial deposits of Beds 5-9, which correlates with West's Stratum A1-A2 (see Chapter 4 and Ashton *et al.*, 2008), possibly indicates the reworking of material from the lower horizons. This observation is supported by the fact that the faunal assemblage is temperate and found in sediments with clearly identified periglacial features, such as ice wedge casts, within these deposits (ibid).

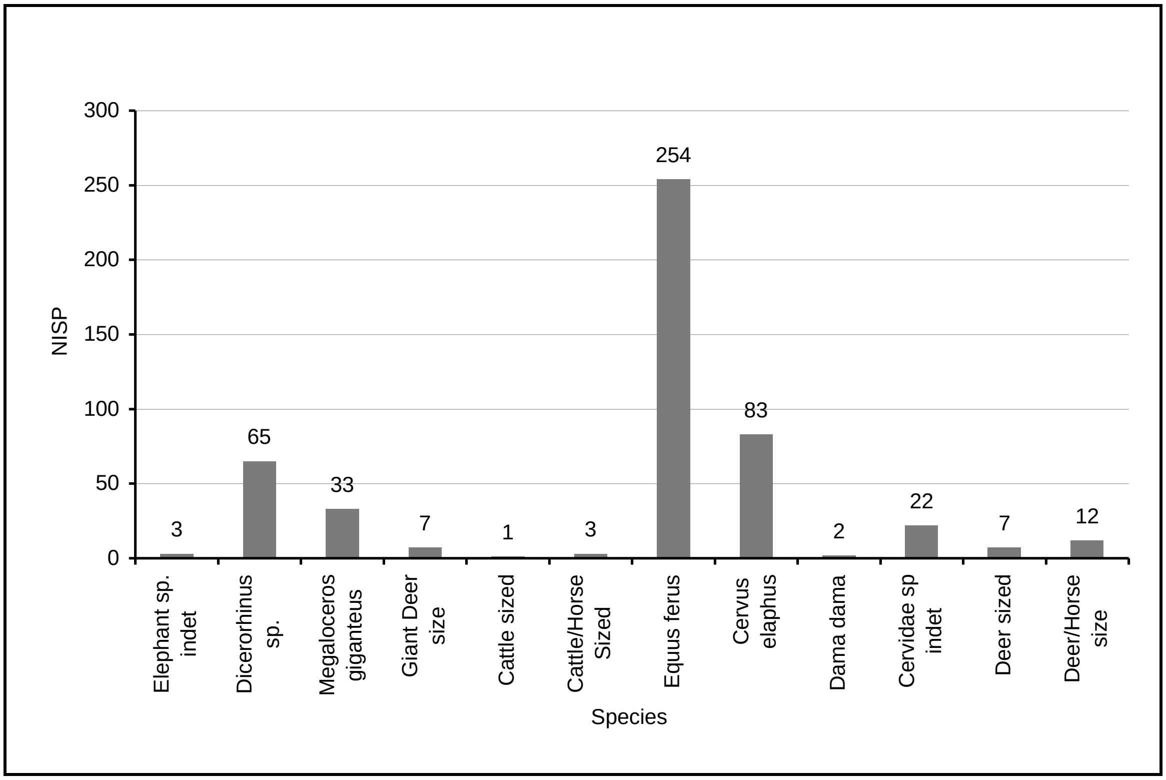

Figure 8.1 NISP by species; arranged by body size from largest to smallest

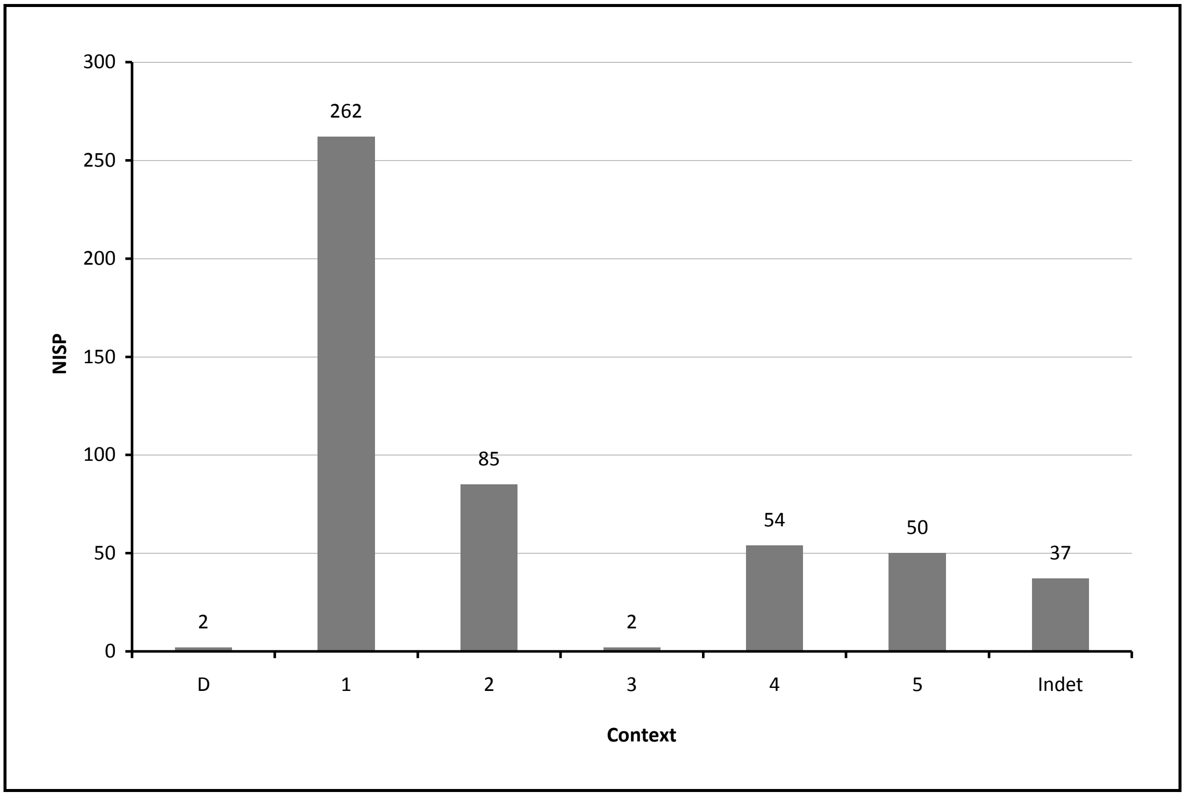

Figure 8.2 Distribution of faunal material throughout sequence Using Gladfelter (1993)

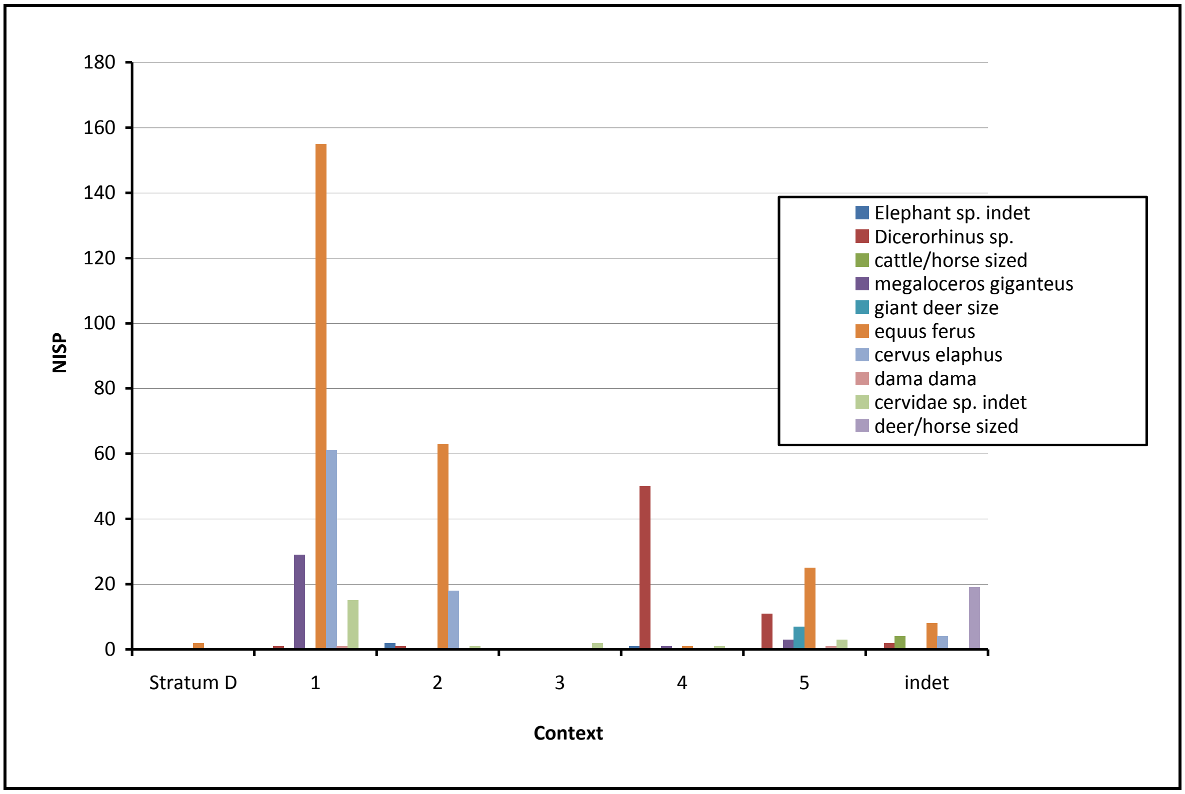

Figure 8.3 Distribution of faunal species throughout Hoxne contexts

Recent work has clarified the stratigraphy at Hoxne and highlighted the presence of a previously unrecognised fluvial channel, which has had an impact on the accumulation and distribution of some of the faunal material. However, there is limited evidence of fluvial modification and rounding, which suggests that faunal material accumulated in the proximity of the river channel and was subsequently incorporated into the channel during high water events that swept material off terrestrial surface and reworked channel banks. Although the faunal material may not be in pristine condition and primary contexts, as seen with most of the Boxgrove material, the fineness of the sediment and the presence of some fish species indicate areas of slack water. Wymer and Singer (1993a) proposed that the presence of bones within these river deposits are indicative of shallow water as such remains would not have survived prolonged exposure on dry land. This latter point is debatable (see Chapter 5) though other natural modifications recorded across the faunal assemblage appear to demonstrate limited exposure to a terrestrial environment, and these agents are considered below.

8.2 Weathering

The weathering of the Hoxne faunal assemblage highlights the fact that the faunal remains exhibited little or no exposure to sub-aerial processes (see Appendix 5 Table 4 and Figure 8.4).

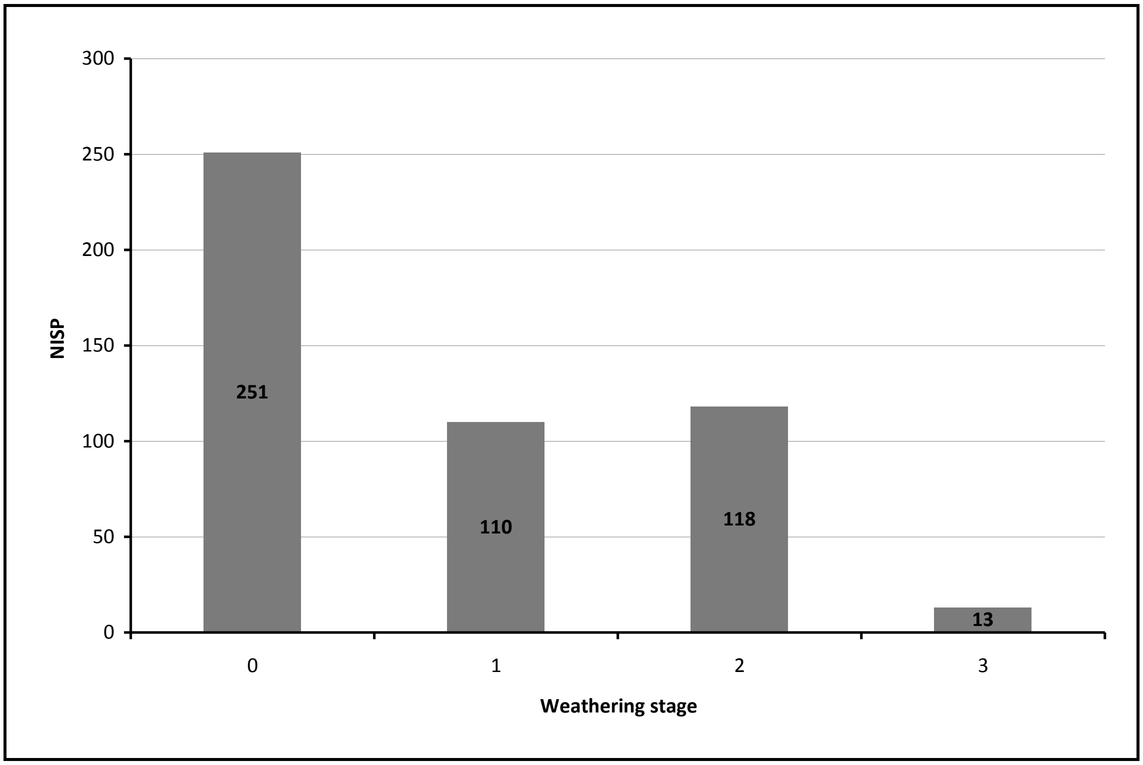

Figure 8.4 General weathering of Hoxne faunal assemblage

The majority of specimens were unweathered (stage 0 NISP= 251), although there were correspondingly high values for stages 1 and 2 with fewest specimens in stage 3 (Figure 8.4 and Appendix 5 table 4). The absence of more heavily weathered material suggests rapid burial with limited disturbance or re-exposure. Breaking the assemblage down by context and species presents a similar weathering pattern to that identified for the assemblage as a whole (see Appendix 5 Tables 5; Figure 8.5 and Figure 8.6). The similarity in weathering patterns throughout contexts and across species indicates that the bone underwent similar deposition processes regardless of context, one of these processes could have been rapid accumulation in to the sedimentary system and/or deposition at the edge of the river channel, which provided some protection from sub-aerial processes.

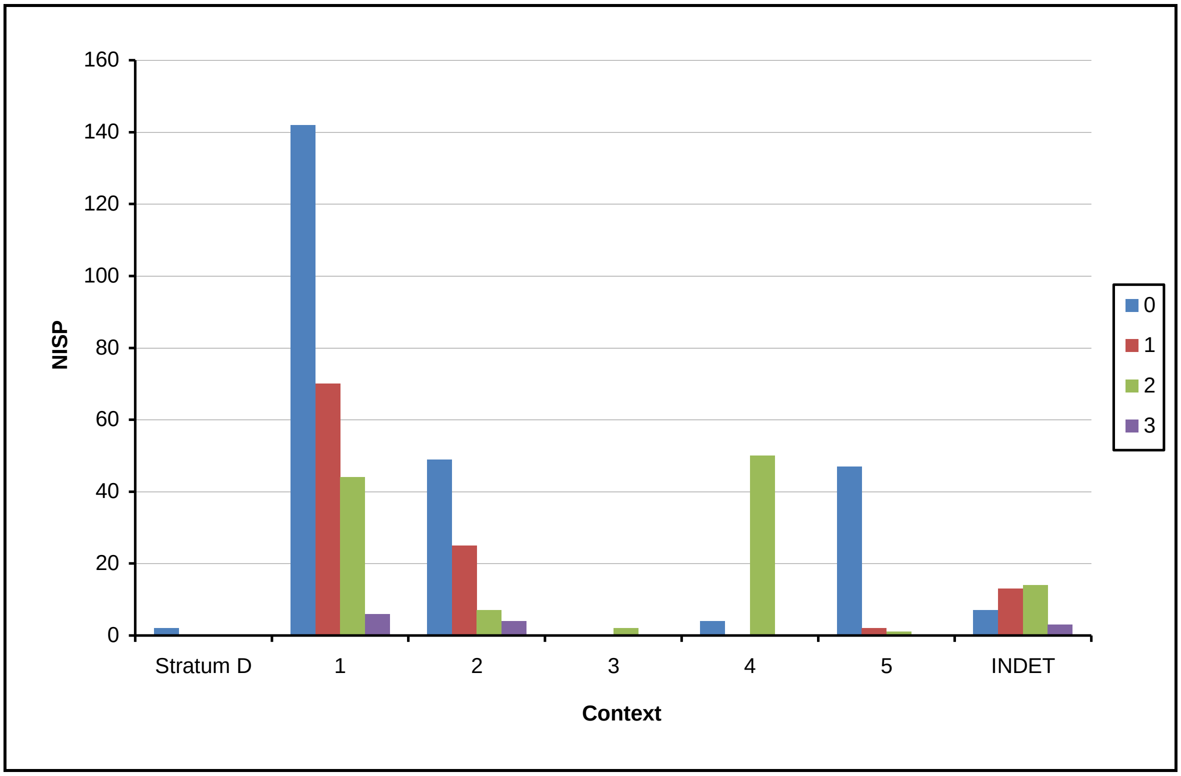

Figure 8.5 Weathering of faunal material within the major Hoxne contexts
Numbers refer to Gladfelter's (1993) determinations

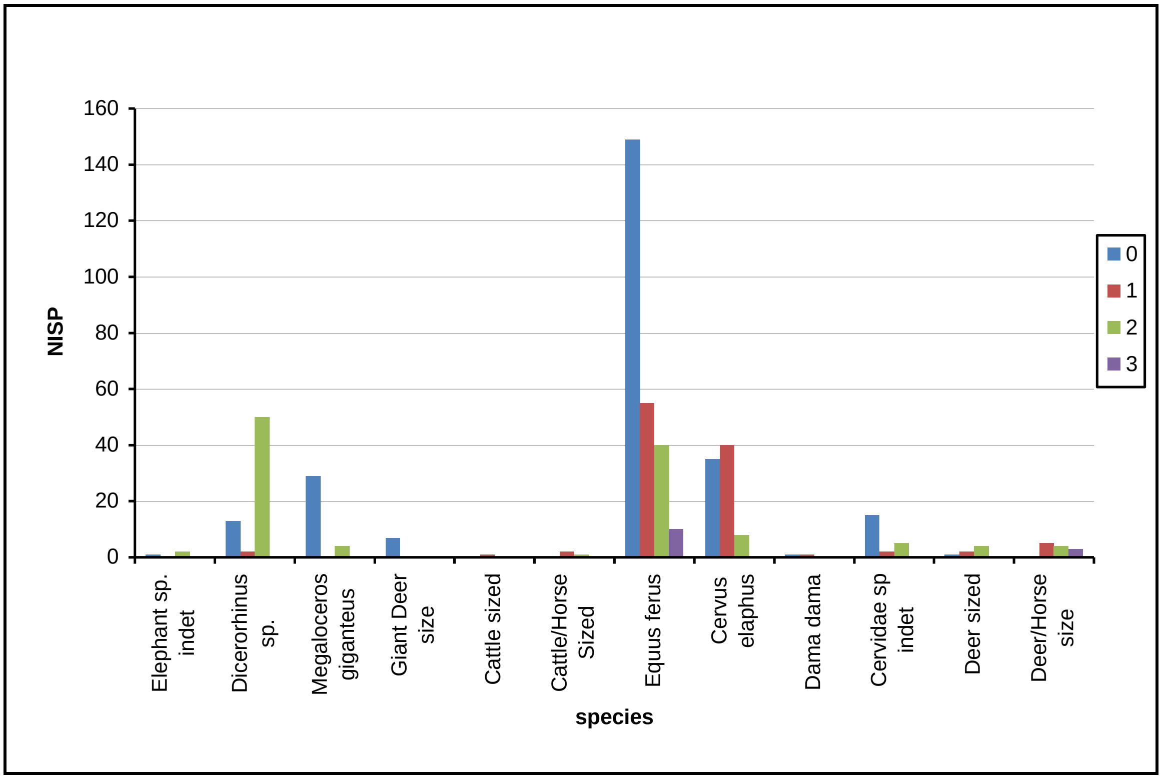

Figure 8.6 Weathering of species in the Hoxne faunal assemblage

The average length and width of the faunal specimens from each weathering stage was calculated and indicates that those specimens more heavily weathered had, on average, larger dimensions (see Table 8.1), although these measurements are based on a small number of specimens.

Weathering Stage	Average Length (mm)	Average width (mm)
0	52.7	20.5
1	96.4	30.6
2	106.9	38.8
3	170.4	45.0

Table 8.1 Average dimensions of faunal specimens in different weathering stages

Despite the uniformity in weathering, the depth of deposits and absence inter and intra-context faunal refitting, within and between contexts, suggests that the assemblage does not represent a single homogenous accumulation event, but rather the attritional accumulation of faunal material at this location (Haynes, 1988b, see later). If these bone specimens remained within the river channel for an extend period of time then this could have prevented exposure to sub-aerial processes, explaining the absence of extensive weathering on these faunal remains.

8.3 Other natural modification

Natural modification is recorded across the faunal assemblage, with most related to terrestrial weathering; particularly cracking (50.2%) and pitting (32.1%) (see Appendix 5 Table 6). The pitting observed on some of the bone surfaces would have occurred during the burial of material along and around the river margins, either naturally or through animal trampling. The limited amount of hydraulic modification (0.61%) demonstrates that the faunal material was not exposed to a high intensity of fluvial action. Nevertheless, the long-axis orientation suggests that these faunal remains were disturbed by fluvial processes perhaps reflecting the incorporation of material from the surrounding channel esge during periods of increased flow. Natural modification of the faunal remains indicates that material was not significantly altered or distorted by natural processes, although the river may have moved/removed certain elements, but the absence of high intensity hydraulic modification suggests a relatively slow river flow regime

Faunal and lithic material has been recovered from most contexts at Hoxne, although the depth of the deposits and spatial distribution of materials demonstrate an attritional accumulation of material rather than single episode deposition. Faunal material accumulated on the margins of a river channel and was periodically incorporated into the sediments perhaps during periods of increased flow (Ashton *et al.*, 2008; Wymer and Singer, 1993a). Analysis of weathering and natural modification demonstrates that these agents had a limited impact on the faunal assemblage. Nonetheless, each species needs to be assessed individually to determine what effect specific bone density has had on element and portion survival and whether these patterns can be attributed to particular agent(s). Although the material may not have moved any considerable distance, discrete 'events' have been disturbed by fluvial action (Ashton et al., 2008).

8.4 Cervids

8.4.1 Red deer

Red deer are one of the more dominant species identified in the Hoxne faunal assemblage (NISP= 83; 16.9%) (see Appendix 5 Table 1 and 7; Figure 8.7 and Figure 8.8).

The material illustrates a dominance of cranial (61.4%) over post cranial (38.6%) remains, with considerable fragmentation of some elements such as the mandible and scapula (see Appendix 5 Table 7). This element fragmentation results in a small MNE/MNI value using skeletal elements (MNE= 2; MNI= 2, based on mandible or 2nd phalanx), although this figure increases when using dental remains (MNE= 4, based on incisor). There is no variation in the MNI value for dental material and, in fact, the value appears to decrease.

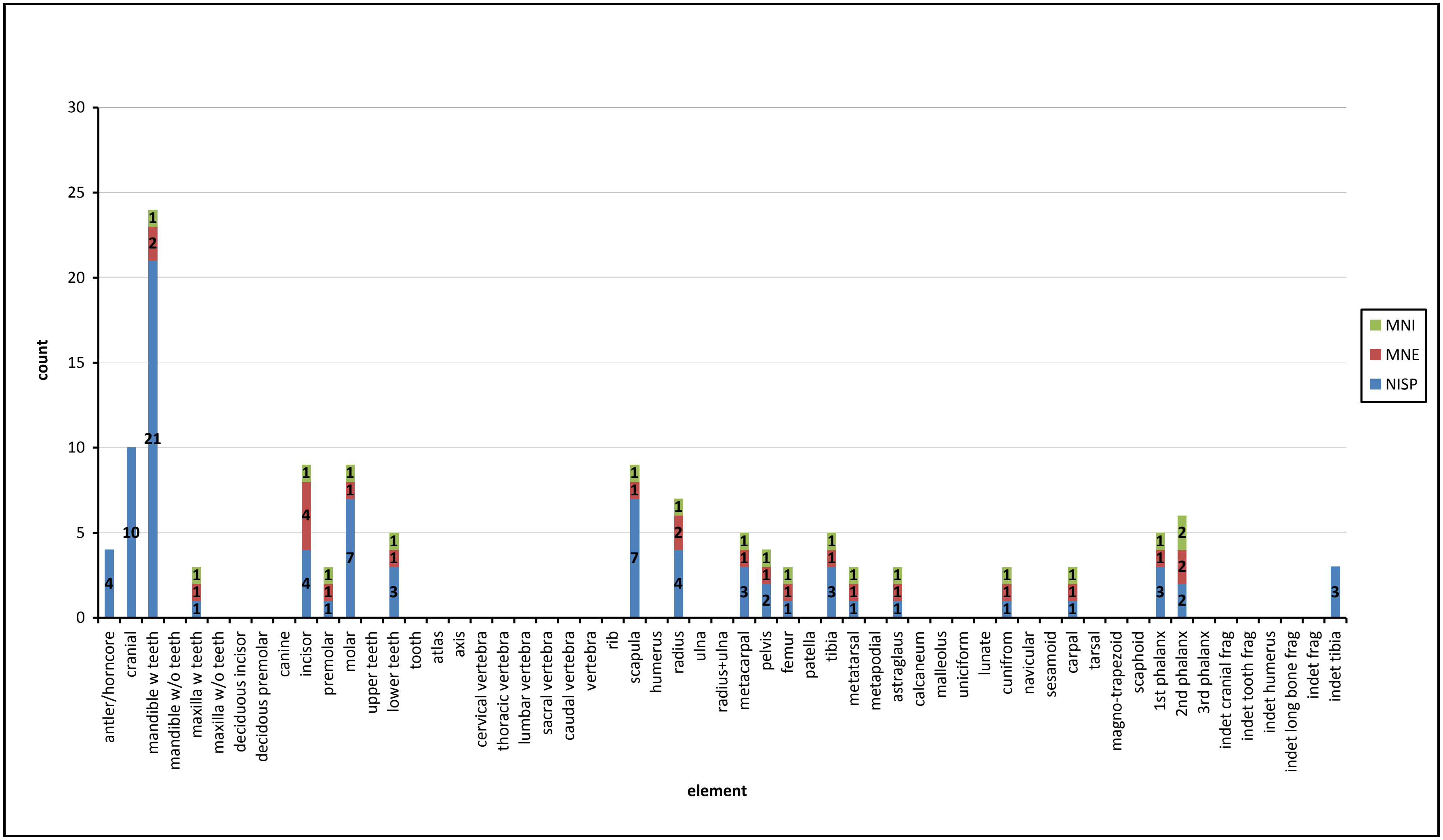

Figure 8.7 Red deer NISP, MNE and MNI values

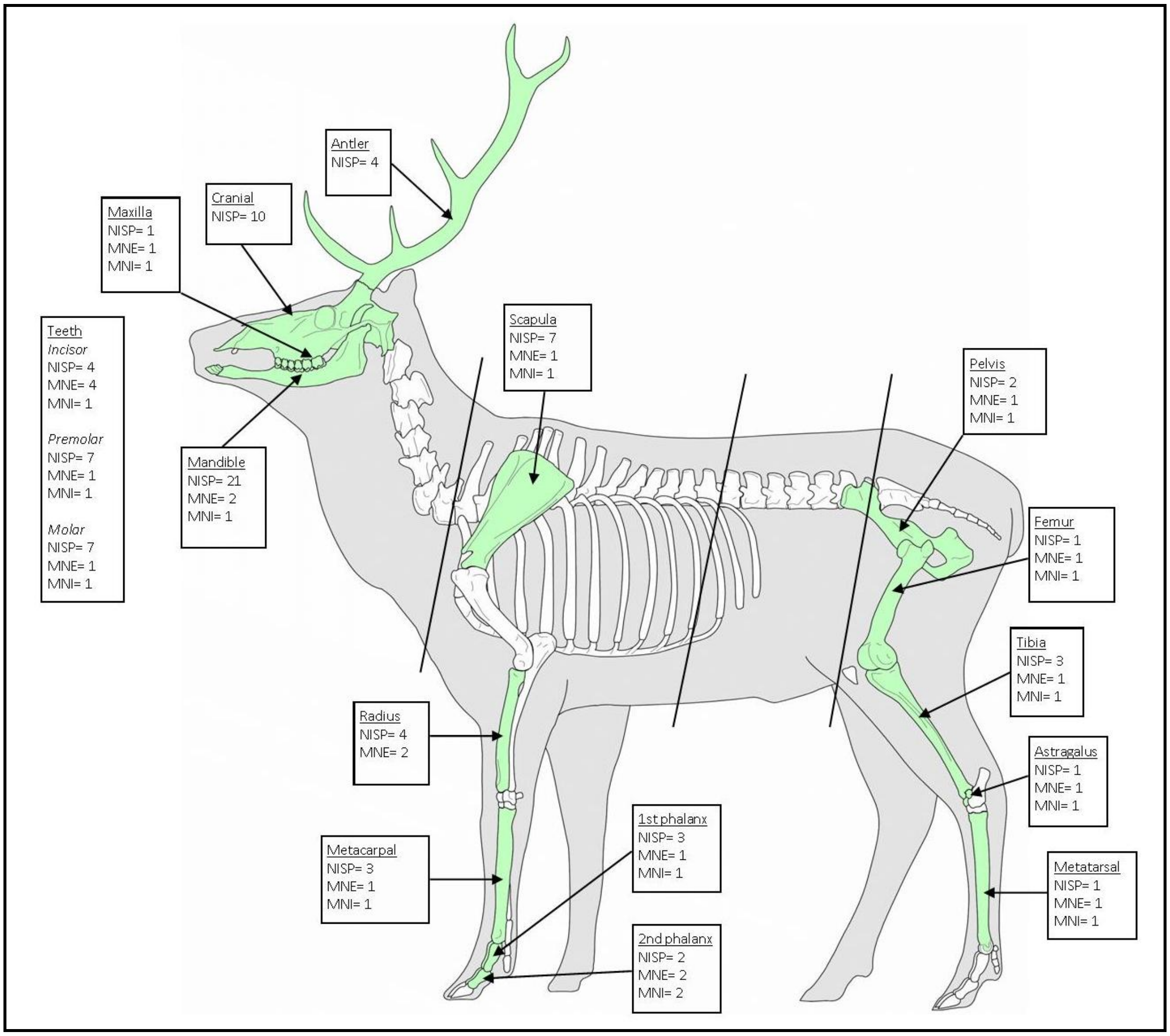

Figure 8.8 Red deer skeletal representation with NISP, MNE and MNI values
Skeletal outline modified from Yvinec *et al* (2007)

A large number of red deer cranial elements were recorded and dominated by mandibular fragments (NISP= 21) accounting for 60.1% of specimens from this region. The mandible is highly fragmented (MNE= 2), and corresponds to a low number of individuals (MNI= 1); the portion survivability of this element suggests that those portions which have survived are the dense areas such as the tooth row and diastema (Lyman, 1994). Such fragmentation could relate to the destruction of weaker mandibular portions through natural processes such as animal trampling. Red deer occipital and frontal fragments (NISP= 10) refit to form a single individual, and demonstrate that bone material has been disturbed but that river flow may not have been powerful enough to transport specimens throughout the river catchment.

Dental and antler remains have a low NISP compared with other study sites (see Chapter 7), although dental remains are relatively complete as illustrated by a high MNE and MNI value (MNE= 4, MNI= 1; based on incisor). All antlers have been shed and may relate to the cyclic loss of such elements at and around this riparian location.

There is a complete absence of the axial skeleton from the red deer skeletal profile. The skeletal representation for cerivdae *sp.indet* demonstrates a similar absence and may therefore indicate that these specimens were destroyed because of their lower relative bone density. The absence of denser portions such as the vertebral centrum and rib epiphyses certainly suggest that faunal accumulation was not the result of relative bone density. Parfitt (*pers comm*) has noted predator-scavenger destruction of the vertebral column at Boxgrove, and a similar form of modification could explain both the fragmentation and absence of this region from the red deer profile.

The post-cranial skeleton illustrates a range of preserved elements, with evidence for fragmentation particularly on the appendicular skeleton (see Appendix 5 Table 8). The scapula is represented by a few specimens (NISP= 7), which refit to form a single element (see Appendix 5 Table 9). The humerus is absent from the skeletal part representation and the radius is recorded by a low NISP (n= 4), which corresponds to a small MNE and MNI value (MNE= 2; MNI= 1). A detailed analysis of each forelimb element suggests that most portions survive and there is little evidence to indicate significant density mediated destruction (see Appendix 5 Table 8). The absence of the humerus could be explained by the natural destruction of this element through predator-scavenger or hominin action. However, the preservation of less dense cranial fragments and other appendicular portions provides convincing evidence to suggest that the absence of this element was not solely a result of differential bone density.

There is some evidence for fragmentation of the hind limb, although refitting pelvic specimens could indicate a relatively undisturbed assemblage. Nevertheless the absence of certain portions, such as the denser acetabulum (see Appendix 5 Table 10), suggests that some fragmentation has occurred. The preservation of all femoral portions does not indicate the differential destruction of less dense portions, although the absence of the proximal tibia could relate to the natural destruction of this weaker portion (see Appendix 5 Table 8).

The lower limb bones and extremities are present, but compared to other sites (e.g. Boxgrove) their numbers are limited. Carpals and tarsals (NISP= 3; MNI= 1) demonstrate very little fragmentation and the majority of specimens are complete, which is an expected pattern with such small, dense elements. A similar pattern of fragmentation was observed on the phalanges, which illustrate some fragmentation (1st Phalanx MNE= 1, MNI= 1; 2nd phalanx MNE= 2, MNI= 2) though these specimens are still either complete or relatively complete.

Detailed analysis of the red deer skeletal remains has highlighted some assemblage fragmentation and a limited amount of destruction/removal of less dense bone elements and portions. The complete absence of particular portions from the axial skeleton and whole elements (humerus) is unusual and could represent the off-site transport of those specimens by taphonomic agents such as the stream system, predator-scavengers, or hominins. However, the presence of other elements of similar density provides a strong argument against the selective removal of these bone specimens based solely on relative mineral density. Although the assemblage indicates a degree of fragmentation the ability to refit specimens perhaps highlights that sedimentary conditions, and in particular the river channel, have not adversely affected assemblage formation, despite evidence of faunal long-axis alignment (Ashton *et al.*, 2008).

Predator-scavenger modification

Only one incidence of predator-scavenger modification was recorded on the distal shaft of a metatarsal (see Figure 8.9 and Figure 8.10).

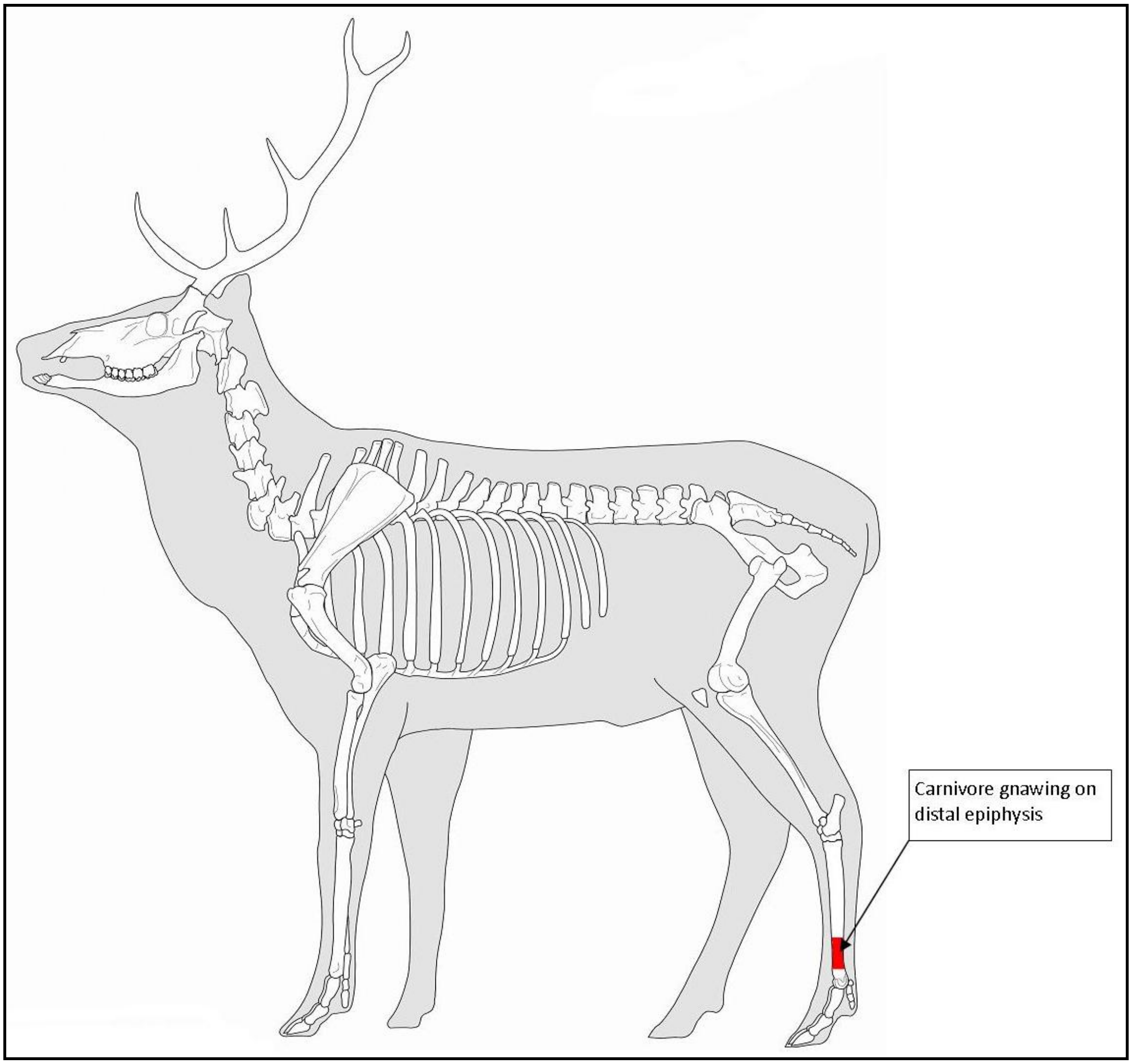

Figure 8.9 Distribution of predator-scavenger modification across red deer skeleton
Skeletal outline modified from Yvinec *et al* (2007)

Figure 8.10 Predator-scavenger and hominin modification on red deer distal epiphysis (HXN 4937) Red arrow predator-scavenger gnawing; blue arrow hominin deliberate fracture

The gnawing modification indicates disarticulation from the lower extremities and suggests that predators had access to some articulated remains. The identification of deliberate marrow fracturing by hominins presumably occurred once the element had been disarticulated and suggests that predator-scavengers had more primary access. There is no evidence of meat removal by carnivores, which has been identified at other sites (see Chapter 6; Lynford) and could suggest an absence of such resources and a more passive strategy that focussed on the exploitation of marrow from an animal that died naturally.

Hominin modification

The deliberate fracture of the same metatarsal specimen indicates marrow-processing (see Figure 8.11 and Figure 8.10). The presence of predator-scavenger disarticulation demonstrates that hominins had secondary access and could represent confrontational scavenging or passive exploitation of resources at a natural death or carnivore kill site.

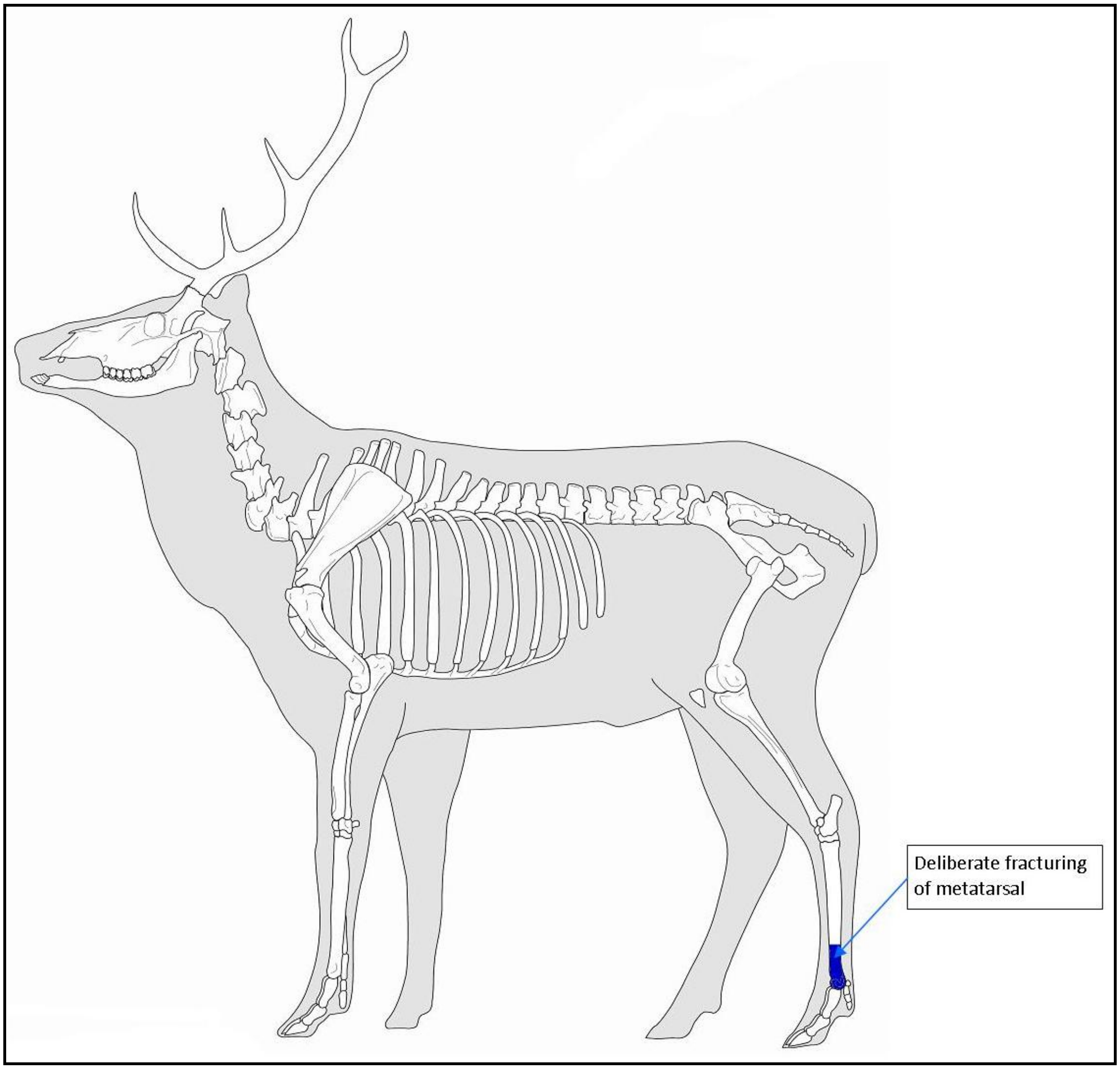

Figure 8.11 Distribution of hominin modification across red deer skeleton; skeletal outline Modified from Yvinec *et al* (2007)

8.4.2 Fallow deer

Fallow deer (*Dama dama*) are represented by a single premolar and tibia specimen, and although more specimens were originally excavated these could not be located or studied for this thesis. The tibia specimen is relatively complete and lacks only the proximal epiphysis (see Appendix 5 Table 11) illustrating a good state of preservation. The absence of the proximal epiphysis does not appear to relate to any predator-scavenger or hominin modification and possibly relates to the natural destruction of this weaker portion through trampling.

The published faunal report highlights that both cranial and post-cranial fallow deer elements were recovered during excavations (Stuart *et al.*, 1993), with the majority of the cranial fragments composed of dental fragments (mainly premolars and molars). The remaining cranial specimens are mainly denser mandiular portions including the tooth row, diastema and ramus. The preservation of cranial material as detailed in the site monograph could indicate the differential destruction of material though this cannot be accurately assessed without a first hand analysis of the material.

The post cranial remains recorded by Stuart (1993) show a similar pattern of element survival to that documented for the red deer skeletal profile. No axial or rib fragments are recorded, which could represent the destruction of these elements by natural processes such as predator-scavenger action. The appendicular skeleton is represented by the denser portions such as the distal humerus and tibia along with large quantities of carpals, tarsals, and phalanges. The identification of denser elements and portions strongly demonstrates differential preservation. This interpretation is based on secondary sources without the author being able to study the material first hand and should be treated with caution. Nevertheless, it does appear that some portions of the fallow deer skeleton are conspicuously absent from the body part representation. It has not been possible to pinpoint the agents responsible for this absence because of a lack of modification by either predator-scavengers or hominins, which might suggest the material accumulated naturally at this location, perhaps through the natural deaths of this individual.

8.4.3 Roe deer

Roe deer remains were not recorded during this study, though some elements were documented during the original analysis and the following interpretation is reliant on material that was not studied first hand during this thesis.

Roe deer remains are represented by a small range of elements, dominated by premolars and molars. The presence of antler and phalanx fragments indicates the differential preservation of denser elements. This observation is supported by the fact that no elements from the axial or appendicular skeleton were recorded which could suggest differential destruction.

8.4.4 Giant deer

Giant deer (*Megaloceros giganteus*) were recovered from the Hoxne deposits, although the amount of material is lower than for other species (see Appendix 5 Table 12). Both cranial and post-cranial elements are recorded, though some of the material detailed in the site report was not available for recording and analysis during this study (Stuart *et al.*, 1993).

The identified elements are mainly from the cranial skeleton and comprise antler (NISP= 4) and indeterminate cranial fragments (NISP= 25) along with two relatively complete skulls, from a separate male and female individual. The male skull preserved the frontal bone, pedicle and parts of the antler base whilst the female skull comprised part of the frontal, parietal and supraoccipital bone with occipital condyles. The extraordinary preservation of both these skulls suggest that the sedimentary conditions were gentle enough to allow for these elements to remain relatively complete. The remainder of the cranial fragments are composed of a single premolar, although other tooth fragments were recorded during the original analysis (Stuart et al., 1993). The presence of relatively complete skulls suggests at least two individuals though cranial and other skeletal remains do not provide similar figures (MNE= 1; MNI= 1; based on premolar)

Post-cranial remains are limited to a single 2nd phalanx (NISP= 1; MNE= 1; MNI= 1) and a cubonavicular, though the latter could not be located for this study. The absence of post-cranial remains is a pattern that is reflected in other cervid species at the site, and could reflect the natural destruction of these elements by carnivores and hominins or off-site transport of these elements. However, the preservation of the refitting skulls along with weathering and sedimentary data suggests that the river channel was not an agent of destruction as documented at other sites, such as Swanscombe, but could still have removed bone elements from the site. The absence of modification from other agents, particularly predator-scavengers and hominins, suggests that these specimens represent the attritional accumulation of material alongside the river channel as a result of natural death.

Predator-scavenger modification

Gnawing on the proximal epiphysis of a 1st phalanx suggests processing for marrow. The absence of other modified elements suggests that predator-scavengers were exploiting carcasses that had accumulated around the river channel through natural deaths.

Figure 8.12 Predator-scavenger gnawing and crenelation on 1st phalanx proximal epiphysis (HXN 2566)

8.4.5 Cervidae sp.indet

Very few specimens were recorded in this category (NISP= 22) (see Appendix 5 Table 13) compared to the other study sites, though some material studied for the previous site report was unavailable for this thesis (Stuart *et al.*, 1993). The material analysed for this study does not illustrate any pattern of bone survival related to the specific mineral density of particular elements or bone portions. This pattern of survival is, however, a function of the small assemblage size. Elements that could be identified included three femur shaft fragments, a humeral distal epiphysis, metapodial fragments, antler fragments, a single tarsal and some indeterminate tibial fragments. It would be unwise to formulate any conclusions about site formation and bone accumulation using such a small assemblage.

8.5 Horse

Horse is the most commonly recorded species in the Hoxne faunal assemblage (NISP= 254; 51.6%) with a NISP count comparable to other study sites (see Figure 8.13 Chapter 5).

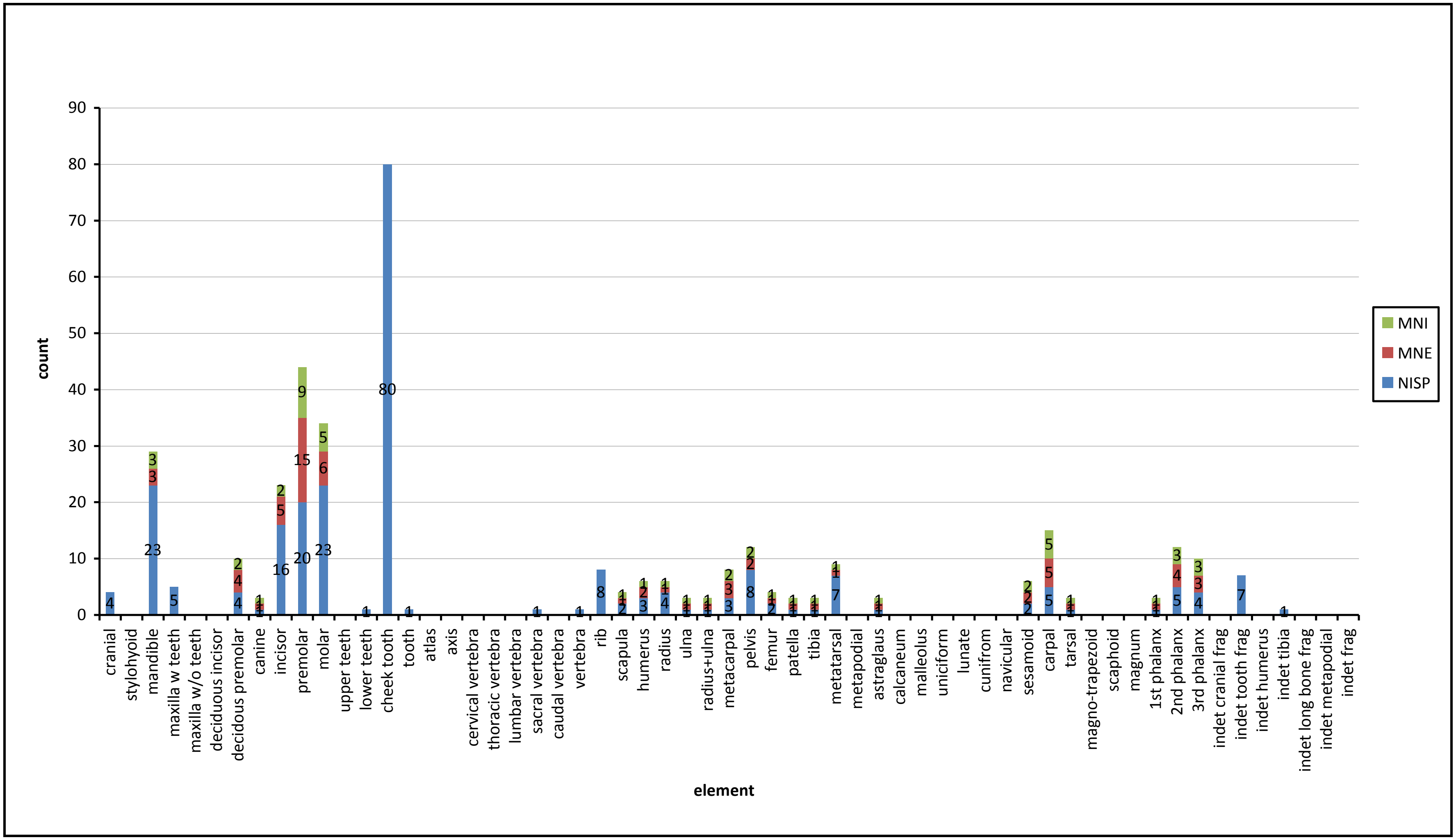

Figure 8.13 Horse NISP, MNE and MNI values

A wide variety of elements are preserved from both cranial (72.8%) and post-cranial (27.2%) regions (see Appendix 5 Table 14 and Figure 8.13).

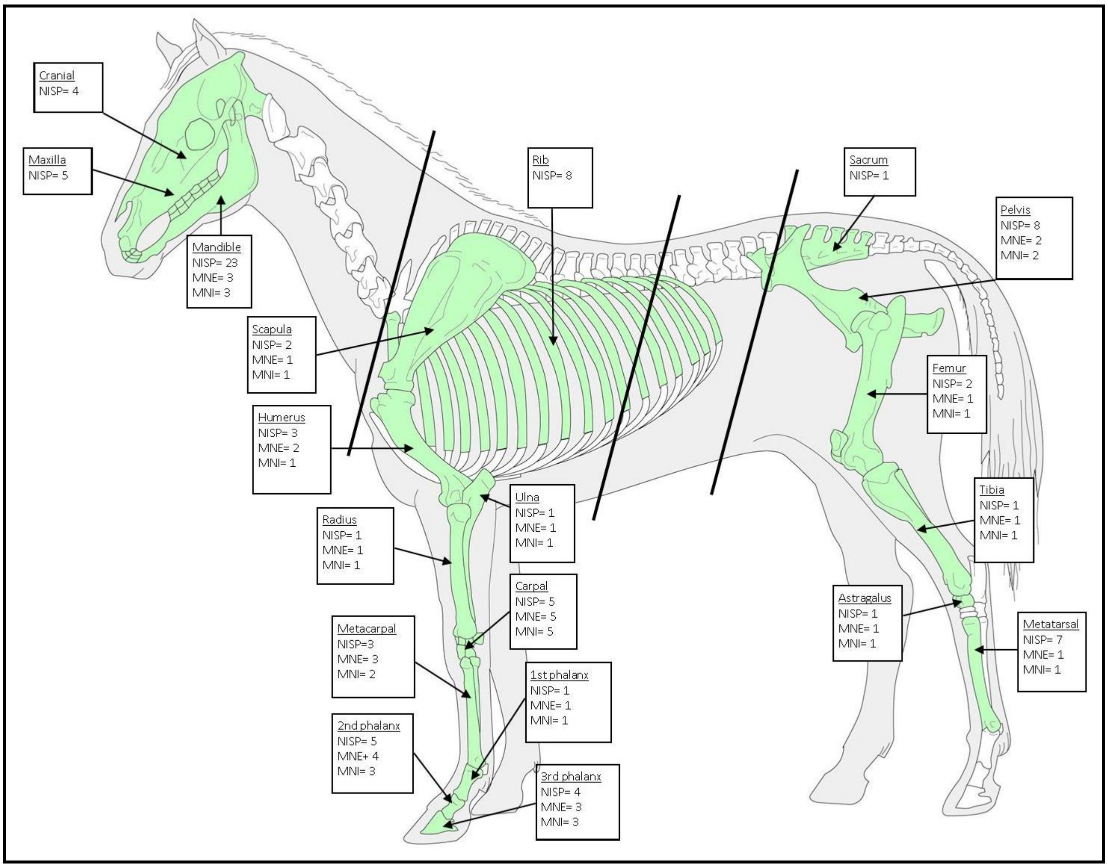

Figure 8.14 Horse skeletal representation with NISP, MNE and MNI values
For dental values see Figure 8.13 and Appendix 5 Table 14 skeletal outline modified from Yvinec *et al* (2007)

Although the NISP value for cranial elements is high, the majority of these are dental specimens (NISP= 146; 79.3%), which equate to a high number of elements and individuals (MNE= 15; MNI= 9; premolars). This high MNI value is not supported by quantification on post-cranial remains (see Figure 8.13). Other cranial vault fragments are limited (NISP= 4) and identifiable specimens are mainly related to the maxilla and mandible (mandible NISP= 23; maxilla NISP= 4), and have undergone significant fragmentation (mandible MNE= 3; MNI= 3). A detailed examination of the recorded mandibular portions highlights that denser regions, including the tooth row and coronoid process predominate, suggesting that less dense regions have been removed, possibly through natural destruction along the channel edge (see Appendix 5 Table 15). However, the identification of deliberate fractures on horse teeth, caused by hominin marrow-processing, provides an alternative explanation for the fragmentation and absence of other mandibular portions (see below).

The axial skeleton is underrepresented (NISP= 10), and the absence of these elements mirrors the patterns observed for other cervid species at Hoxne (see Section 8.4; Appendix 5 Table 16). The absence of other specimens from the axial skeleton suggests that some destruction or off-site transport of bone specimens has occurred, perhaps related to both fluvial and hominin action (see below). The preservation of relatively complete ribs and vertebral portions highlights that faunal assemblage accumulation occurred in relatively low energy sedimentary conditions perhaps on the margins of the river channel, which is supported by weathering and natural modification data (see above).

The equid appendicular skeleton is represented by a small number of specimens (see Figure 8.13 and Appendix 5 Table 17). The forelimb specimens correspond to a small number of elements and individuals (see Appendix 5 Table 14) and do not indicate significant fragmentation. A similar pattern is, again, illustrated on the hindlimb. Unlike the lower limb bones, the pelvic region illustrate some fragmentation, though these specimens represent a high number of elements and individuals (MNE= 2; MNI= 2). A few specimens from the extremities of both fore and hind limbs are present (see Appendix 5 Table 14). The preservation of numerous portions of the appendicular skeleton, not simply the denser shaft portions, indicates that bone survival was not entirely related to specific density (see Appendix 5 Table 17). In addition, if the faunal assemblage represented a pattern of survival resulting directly from relative bone density the skeletal extremities should perhaps show far greater representation. The absence of the axial skeleton suggests that a limited degree of differential destruction has occurred or off site removal. Although the assemblage indicates a degree of fragmentation the ability to refit specimens indicates deposition in a low flow regime on the edge of the river channel (Ashton *et al.*, 2008). The small number of faunal refits, compared to sites like Boxgrove, suggests the sporadic disturbance and possibly selective transport of elements as suggested by the skeletal representation and long-axis orientation.

Hominin modification

Only hominin modification was identified on horse remains, and on a limited number of specimens (NISP= 12; 4.7%) (see Figure 8.15).

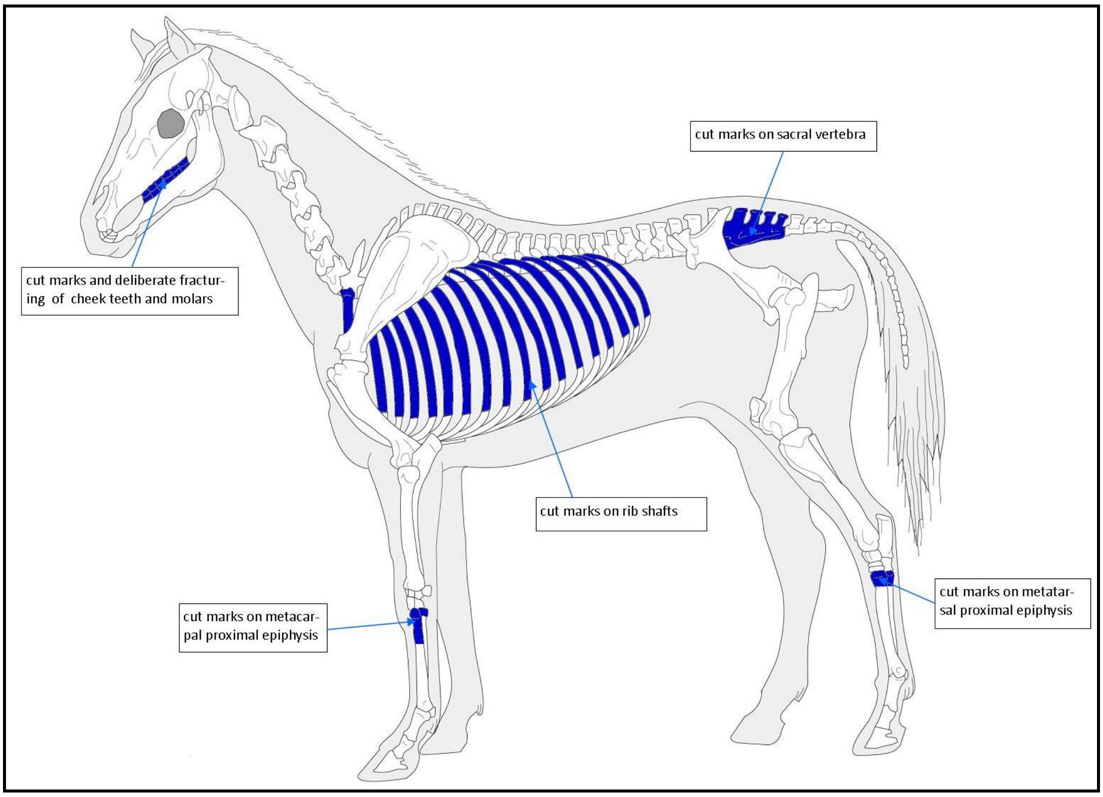

Figure 8.15 Distribution of hominin modification across horse skeleton
Skeletal outline modified from Yvinec *et al* (2007)

Figure 8.16 Deliberate fracturing of horse molars

Most hominin modification is related to marrow-processing of the mandible, which caused horse cheek teeth to fracture (see Figure 8.16); similar modification has been identified at other study sites (see Chapters 5 and 6). The remainder of the hominin modification consists of cut marks on various elements including a metapodial, ribs and sacral vertebra (see Figure 8.16, Figure 8.17 and Figure 8.18). The location of the cut marks on the rib shafts and sacral vertebra indicates the removal of small portion of remaining meat tissue on these elements. Cut marks on a metapodial shaft and epiphysis is indicative of skinning and disarticulation of the lower extremities from the appendicular skeleton, perhaps related to the removal of carcass parts by hominins.

Figure 8.17 Cut marks on proximal epiphysis of horse metatarsal (HXN 5322)

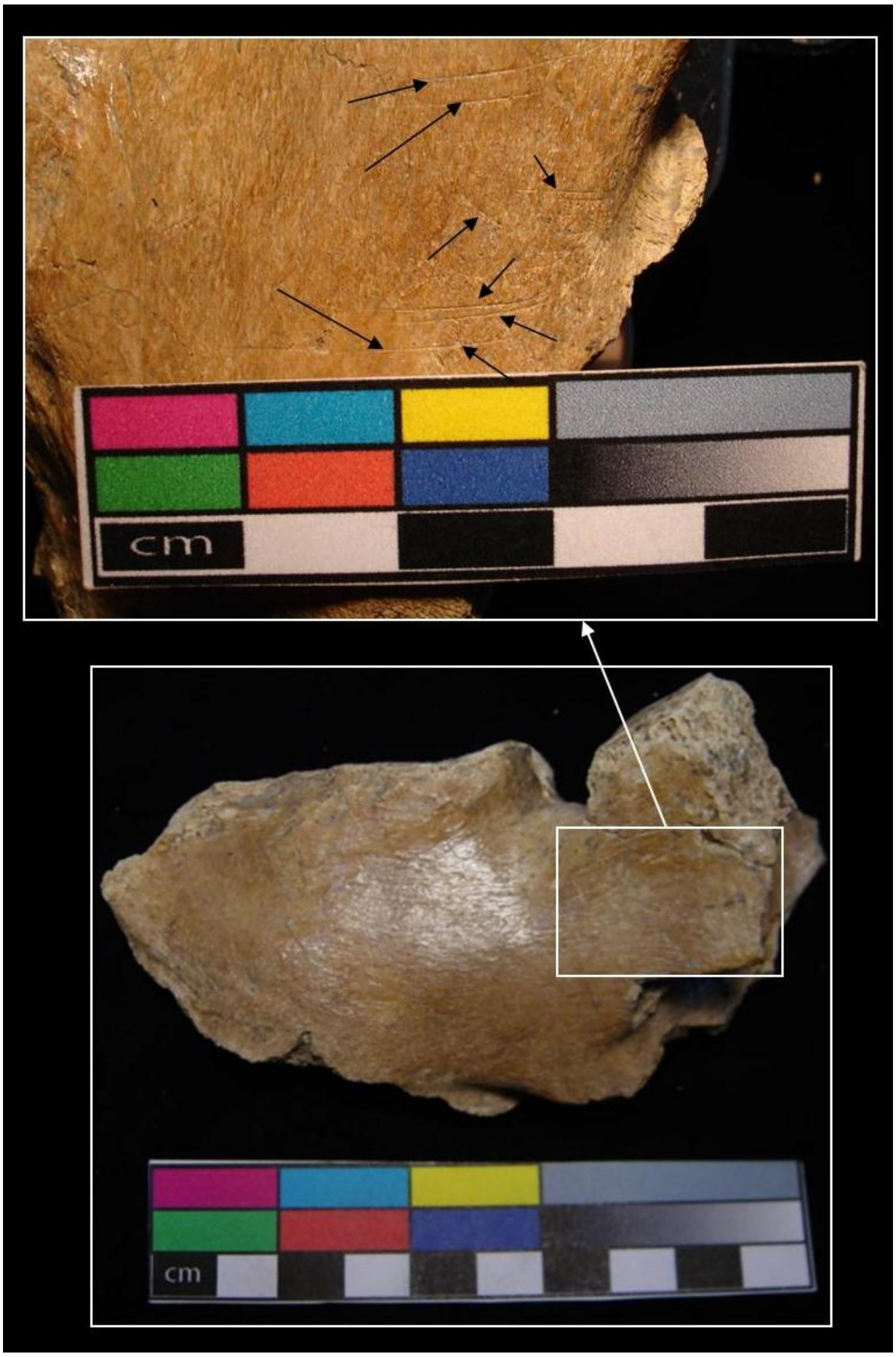

Figure 8.18 Cut marks on horse sacrum from Hoxne

8.6 *Megafauna*

8.6.1 Dicerorhinus sp.

This extinct rhinoceros is the best represented of the megafaunal species (NISP= 65; 13.2%) (see Appendix 5 Table 18 and Figure 8.19).

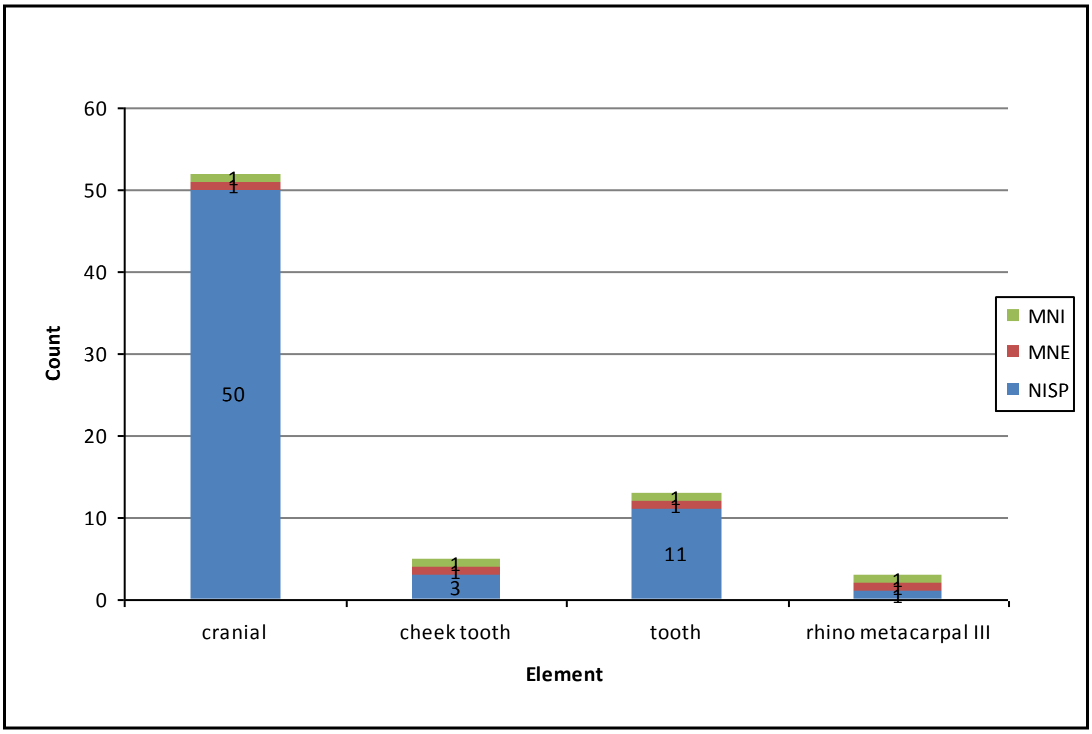

Figure 8.19 Dicerorhinus sp. NISP, MNE and MNI values

The majority of specimens are composed of cranial (NISP= 50) and tooth fragments (NISP= 13), though the former is represented by a single cranium. The teeth specimens are so fragmented that they cannot be accurately identified to element. The remaining elements include a near complete metacarapal, which only lacks the proximal epiphysis. Quantification suggests a single individual and not the mass death of numerous animals (MNE/MNI= 1; see table). The scarcity and fragmentary nature of these remains and the absence of any predator-scavenger/hominin modification suggests that the preserved specimens represent the natural death of an animal near to the river channel.

8.6.2 Elephant sp. indet

Elephant remains include a single tusk and proximal ulna fragment. The number of specimens is extremely small and makes it impossible to draw accurate conclusions about assemblage formation. However, the scarcity of remains, absence of predator-scavenger and hominin modification may suggest a natural accumulation of this material. Other remains are listed in the site report, though these could not be located for this study. The material recorded by Stuart (1993) indicates the survival of denser portions such as teeth and distal long bone epiphyses, and suggests that these specimens have accumulated naturally. However, without access to all the faunal material this conclusion should be treated with caution.

8.7 Indeterminate Species

8.7.1 Giant deer size

This general category is represented by a few indeterminate tooth specimens (NISP=7) and provides no useful information regarding assemblage formation.

8.7.2 Cattle sized

This size category is represented by a sole rib fragment and provides no useful information regarding assemblage formation.

8.7.3 Cattle/horse sized

Cattle/horse sized elements are represented by a limited number of rib fragments (NISP= 3), although the preservation of predator-scavenger gnaw marks and cut marks on these specimens suggests disarticulation and a relatively complete individual. The quantity of bones is too small to be used to accurately understand assemblage formation.

8.7.4 Deer size

Deer sized fragments are represented by rib fragments (NISP= 19) with cut marks. These modifications perhaps suggest the disarticulation and removal of meat from a more complete individual.

8.8 Assemblage fracture patterns

Some fractured elements were recorded which were all are related to marrow-processing by hominins (see Table 8.2). This type of modification suggests that limited resources were available at the site and highlights a more opportunistic exploitation strategy focussed on resources from carcasses that had accumulated naturally. The absence of hydraulic rounding on any of the fractured bone suggests that these elements were not submerged in a fluvial environment for a long period of time. However, the faunal long-axis alignment certainly suggests that the river channel has had some influence in faunal accumulation and modification, even though the river flow regime was slower compared to some of the other study sites (see Chapter 7).

Species	Element	Fracture Type	Fracture edge	Modification
cervus elaphus	metatarsal	spiral	rough	yes
	metatarsal	spiral	rough	yes
equus ferus	lower premolar	smooth perpendicular	rough	yes
	lower molar	flaking	rough	yes
	lower molar	flaking	rough	yes
	lower molar	smooth perpendicular	rough	yes
	indet tooth	irregular perpendicular	rough	yes

Table 8.2 Assemblage fracture patters

8.9 Discussion

This analysis of the Hoxne faunal assemblage has been affected by the unavailability of all the material listed in the original site report (Stuart *et al.*, 1993). However, from the material studied for this project it has been possible to highlight some details regarding site and assemblage formation

Recent work has highlighted a previously unrecorded river channel, and further research by Parfitt has demonstrated fluvial alignment to the direction of previous channel flow (Ashton *et al.*, 2008). Weathering of the faunal material highlights that most of the elements illustrate limited or no weathering indicative of rapid burial and limited re-exposure. The weathering pattern is similar throughout all contexts and suggests that material was rapidly incorporated into the channel environment. The long-axis alignment indicates exposure of bone specimens within the river channel. Despite this long-axis orientation, the amount of recorded hydraulic modification is low, which suggests a low energy river flow regime. In addition, faunal material that was deposited in the river channel could have been protected from extensive sub-aerial processes, which would explain the similarities in weathering patterns.

Analysis of the species at Hoxne highlights that most faunal elements have survived without evidence for density mediated destruction. The medium-sized species (cervids, equids) illustrate the survival of most elements, with fragmentation across most of the skeleton. The ability to refit faunal specimens demonstrates that depositional conditions were not as severe as at some of the study sites (see Chapter 7). The complete absence of some portions (particularly the vertebral column) and elements (humerus) is interesting and it has been noted that predator-scavenger target the vertebral column for nutrients, although this pattern could also reflect the natural destruction of this weaker portion. The uniformity of the weathering pattern and the absence of significant amounts of natural modification perhaps suggests the accumulation of bone material in a natural, attritional assemblage in and around the riparian environment.

8.9.1 The role of hominins and predator-scavengers

Evidence of hominin and predator-scavenger modification has been identified and discussed for all species. The quantity and distribution of modification does not correlate with any of the other study sites. There is no direct association between the lithic and faunal material as both have been disturbed by their proximity to the river channel. Hominin and predator-scavenger modification cannot be discussed in terms of meat-procurement behaviour but rather in terms of ‘access’ to resources.

Bone surface modification is highlighted on a small number of specimens (4.2%). The majority relates to hominin butchery and carcass-processing (3.5%) whilst some relates to predator-scavenger modification (0.7%). These figures are still far short of the modification highlighted on the large/medium-sized species from Boxgrove (20%). Predator-scavenger modification is only represented by the gnawing of a single giant deer phalanx, which suggests processing for marrow. However, the absence of overlapping modification signatures does not allow for a consideration of hominin and predator-scavenger access to resources and potential competition.

The pattern of hominin modification on most species is related to the disarticulation of skeletal elements and extraction of marrow. On some cervid species, particularly red deer, there is evidence for primary access to limb bone marrow and the absence of cut marks on these specimens suggests that limited meat resources was available. Similarly, broken equid teeth suggest the deliberate fracturing of the mandible, again, to extract the marrow. Cut marks on the rib and sacrum indicates meat removal from these regions and suggests that hominins had primary access any remaining meat tissue on these elements. The absence of cut marks on major meat bearing elements and the identification of a fragmented, attritional assemblage suggests that these carcasses were not directly acquired by hominin communities but represent the scavenging of meat scraps and marrow resources from natural deaths around the river environment. However, the presence of disarticulation marks on the lower extremities may indicate the removal of other appendicular elements offsite, which could explain their absence in the skeletal part profile. Nevertheless, the evidence from Hoxne indicates a strategy focussed on marrow and smaller meat scraps rather than on a more holistic utilisation of the carcass as exhibited at Boxgrove.

The site of Hoxne demonstrates the accumulation of material around a river channel. The bones appear to have been modified in terms of orientation by fluvial action but direct evidence of fluvial modification on the faunal remains is minimal. Nevertheless the weathering and natural modification of the assemblage indicates that the river channel provided a relatively stable depositional environment, perhaps due to the low energy flow regime. The fragmentation and differential destruction of certain skeletal elements appears to have been relatively low and could again reflect a gentle depositional environment.

The limited quantity of hominin and predator-scavenger modification highlights a focus on bone marrow, although some of the hominin modification does indicate the removal of small amounts of meat from certain skeletal portions. The absence of predator-scavenger and hominin modification might relate to the small assemblage size compared to other study sites. The Hoxne faunal assemblage cannot be used to construct complex behavioural models about hominin meat-procurement and access to resources. The evidence illustrates a hominin presence and utilisation of these carcasses but at present it is only possible to view small scale, isolated patches of behaviour that have been masked and disturbed by other taphonomic processes.

Chapter 9 Site based comparison and the evolution of human hunting behaviour

The preceding chapters have provided unique primary data and background information about four key Palaeolithic localities; each site has been treated individually in terms of site formation processes and hominin behaviour. The reasons for such an approach have been discussed previously, but primarily this was from a desire to understand each site holistically before attempting any comparisons within or between other sites. This chapter will provide a comparative discussion of the similarities and differences in terms of site formation and hominin behaviour at each location. Such an approach will emphasise the importance of a holistic methodology and provide justification for considering the site formation histories and hominin behaviour at each site initially in isolation from each other. In addition to comparisons between each of the study sites this chapter will introduce appropriate comparisons between sites in the wider European context. By comparing primary data from this thesis with data from other European sites will emphasise the problems and challenges that Palaeolithic researchers encounter when assessing the role that hominin communities played in faunal accumulation. The final part of the chapter will draw out the implications of this research in relation to the evolution of hominin meat-eating behaviour.

9.1 Study site comparisons

Each study site has been analysed separately to provide a comprehensive account of the site formation history at each location. The purpose of this section is to draw on data from each of the study sites to substantiate previous claims for similarity/difference between them. However, it is essential that the data selected for each site is comparable. Therefore, inter-site comparisons will not focus exclusively on general site based comparisons but will identify similarities and/or differences in weathering and modification at each site in horizons with similar accumulation conditions.

9.1.1 Inter-site comparison 1: Weathering in different depositional environments

Sub-aerial weathering was recorded on all animal taxa at each study site and within horizons that formed as a result of different accumulation conditions. Boxgrove (89%), Swanscombe (97.8%), and Hoxne (97.4%) have higher percentages for unweathered-lightly weathered bone (stages 0-2) compared to more heavily weathered material (stages 3-5) (see Figure 9.1; Appendix 6 Table 1). In contrast, faunal material from Lynford is more evenly distributed between unweathered-lightly weathered (49%) and heavily weathered (51%) material (see Figure 9.1). Such a variation supports the previous assertion that faunal material at Lynford was deposited over a longer period of time and frequently re-exposed. In contrast, faunal material deposited at the other three study sites was buried quickly and suffered little or no re-exposure. In order to see whether sub-aerial weathering varies between each study site it is useful to see whether such discernable variation can also be demonstrated across material from different depositional horizons and taxa of different sizes.

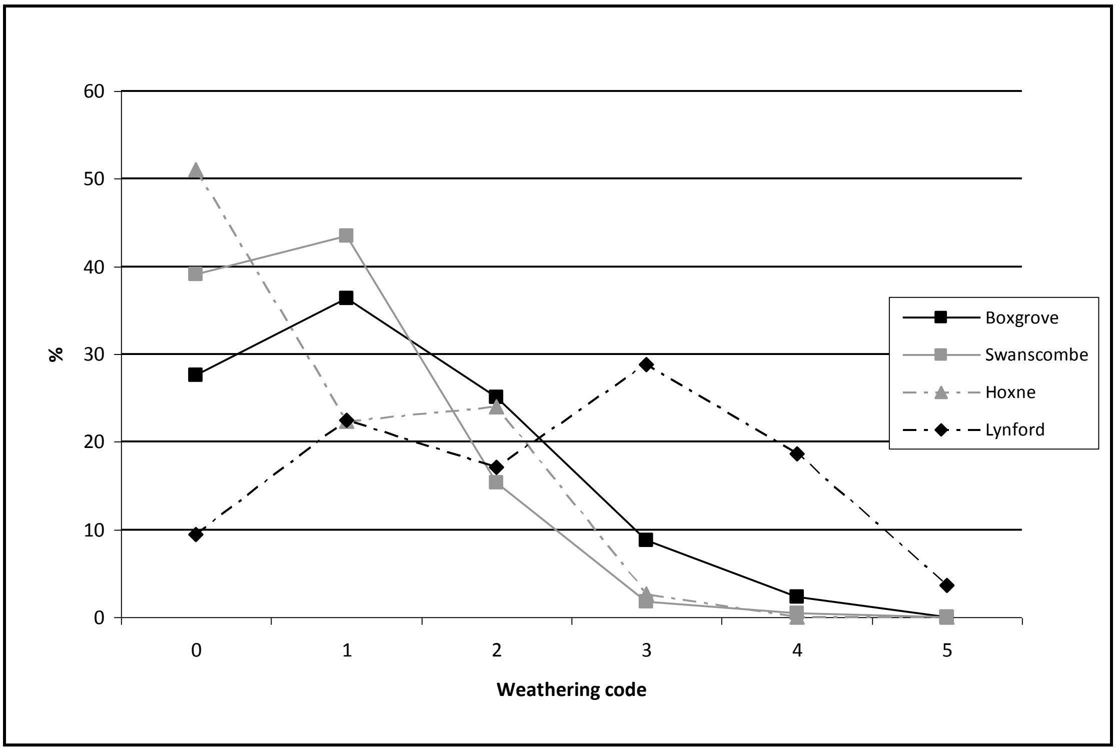

Figure 9.1 Percentage of NISP falling into each weathering stages at each study site.

9.1.1.1 Fluvial deposits

Horizons deposited through river action were identified at Boxgrove, Swanscombe and Hoxne (see Chapter 4), although there was considerable variation in the duration and intensity of the river regime at each site (see Roberts and Pope, *in press*; Ashton et al, 1996; Gladfelter, 1993). The channels at Swanscombe and Hoxne were cut by rivers with increased discharge capable of transporting material over greater distances; in contrast, the channel at Boxgrove was cut by springs, which discharged from the base of the disused cliff, only 50m to the north. The base of this channel was cut into the Sildon Silts (Unit 4b) but would have been obscured by tidal processes until the final retreat of the sea and the establishment of a terrestrial land surface (Unit 4c). These springs had neither the capacity nor drainage area for extensive faunal transport, winnowing and destruction compared to river systems at Swanscombe and Hoxne.

Despite such differences in channel size and discharge, the weathered material from these fluvial horizons highlights a similar pattern of sub-aerial weathering to the general pattern identified previously (see Table 9.1; Figure 9.1). Faunal material recovered from these horizons illustrates a large percentage of unweathered/lightly weathered elements (Boxgrove, 87.3%; Swanscombe, 98.1%; Hoxne, 97.5%).

Material from these deposits has subsequently been divided by animal size categories (based on Bunn, 1991). Large species included: elephant, rhino, bovids, equid and giant deer whilst medium species include all other species of deer. Breaking the faunal material from these deposits down by animal size categories demonstrates a similar pattern of sub-aerial weathering, which is extremely well highlighted by a comparison of red deer from all three locations (see Appendix 6 Table 2; Figure 9.2)

	Weathering Stages					
Site	**0**	**1**	**2**	**3**	**4**	**5**
Boxgrove	55 (28.1)	69 (35.2)	47 (24.0)	20 (10.2)	5 (2.6)	0.0
Swanscombe	197 (39.1)	219 (43.5)	77 (15.3)	9 (1.8)	2 (0.4)	0.0
Hoxne	195 (48.4)	95 (23.6)	103 (25.6)	10 (2.5)	0.0	0.0

Table 9.1 NISP recorded in each weathering stage for faunal material from fluvial deposits; numbers in parentheses are % of total NISP for each weathering stage.

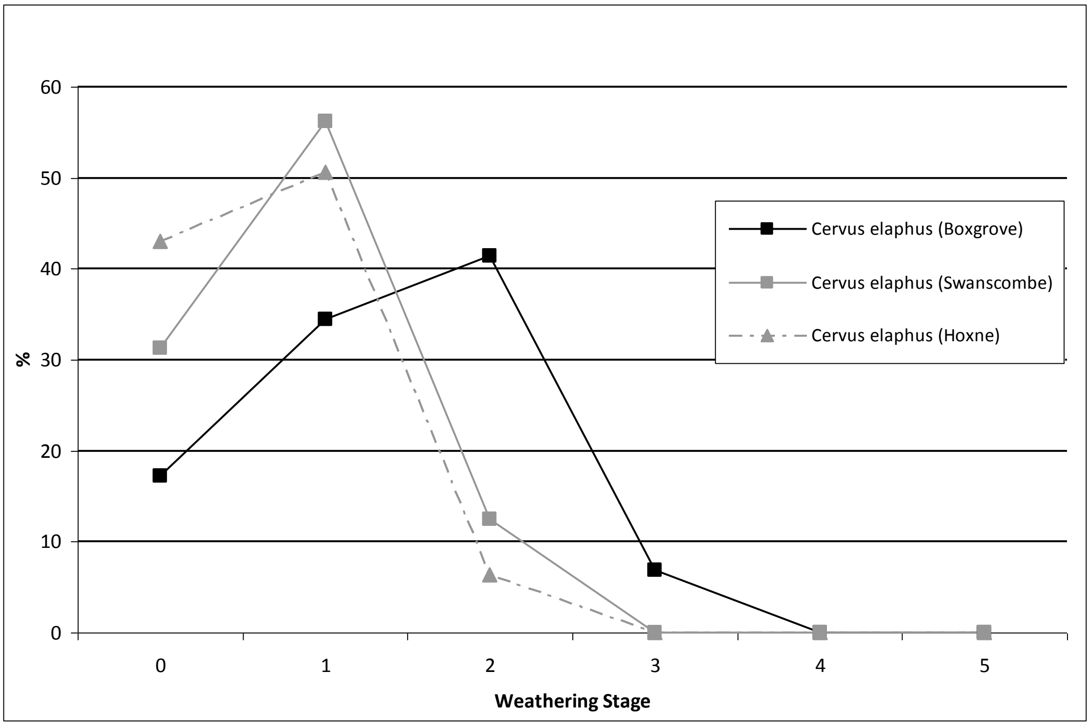

Figure 9.2 Percentage of red deer NISP in each weathering stage from fluvial deposits at Boxgrove, Swanscombe and Lynford.

Weathering across red deer elements from all three study locations indicates higher percentages of specimens in the unweathered/lightly weathered categories (Appendix 6 Table 2; Figure 9.2). Although other species were recovered from these fluvial deposits the assemblage sizes were not sufficient to affect comparison within and between sites. The absence of heavily weathered material from any of the fluvial horizons at these sites supports the idea of rapid incorporation of faunal material into the river channel, which subsequently resulted in limited re-exposure to sub-aerial processes. Some re-exposure has been identified at some sites where specimens have evidence for both sub-aerial weathering and fluvial rounding (cf. Figure 7.7)

9.1.1.2 Lacustrine deposits

Lake deposits were identified at Boxgrove and Lynford. The weathering papttern on the faunal material from the Boxgrove deposits is similar to that identified on material from the fluvial deposits with a large percentage of material in the unweathered/ lightly weathered category (90%) (see Figure 9.3; Appendix 6 Table 3). Analysis of the species from these deposits highlights a similar pattern with most having over 50% of specimens in the un-weathered/lightly weathered categories (see Appendix 6 Table 4; Figure 9.4). The distribution of the weathering across species suggests that faunal material from Boxgrove was quickly incorporated into the sediments and remained relatively undisturbed. This interpretation is supported by the weathering of faunal material from other deposits at Boxgrove and the evidence for refitting faunal and lithic material throughout horizons with different depositional environments (see above; Roberts and Parfitt, 1999).

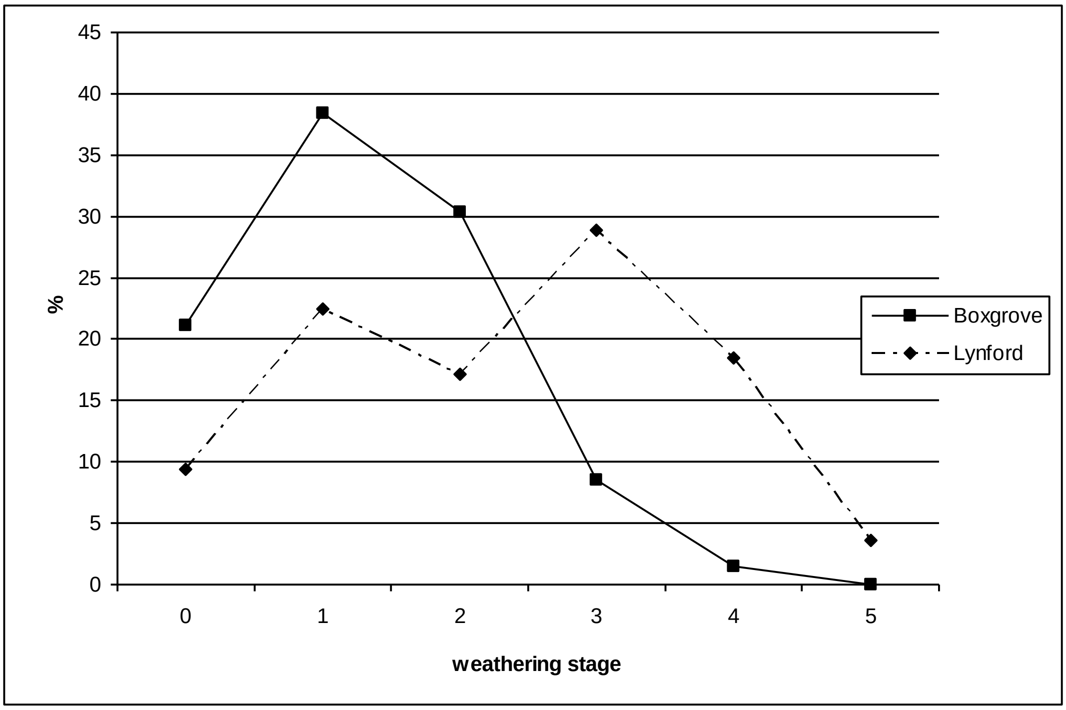

Figure 9.3 Percentage of NISP from each weathering stage in lacustrine deposits at Boxgrove & Lynford.

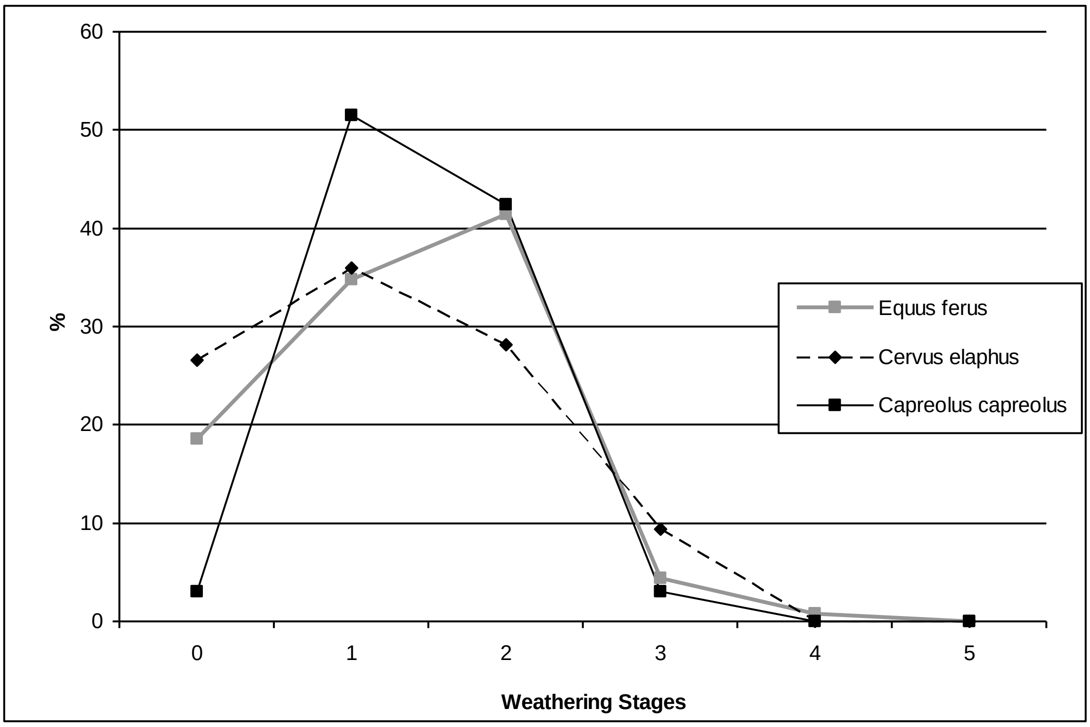

Figure 9.4 Percentage of NISP in each weathering stage from the Boxgrove lacustrine deposits; by species.

The pattern of weathering across material from lacustrine deposits at Lynford is different to that identified at Boxgrove. Approximately half of the Lynford material is heavily weathered (51%) (Appendix 6 Table 5; Figures 9.3 & Figure 9.5). Once the faunal material is broken down by species at Lynford, a similar weathering pattern emerges; only rhino (93.1%) and reindeer (68%) have higher percentages of lightly weathered material. The variation in weathered material at Lynford could be related to the slumping of faunal material into the channel from the margins and later becoming re-exposed by either animal kicking/trampling or scavenging by hominins and/or other predators. The more seasonal palaeo-climate recorded for Lynford, with lower mean winter temperatures, could have helped to preserve faunal material for longer than at Boxgrove. The intensive butchery of carcasses around the margins of the Q1/B waterhole at Boxgrove may have left few resources, presenting an unattractive proposition for other non-human scavengers. Subsequent trampling or disturbance at Boxgrove could have caused the slumping of faunal material into the water from the margins, rapidly burying these remains and protecting them from serious sub-aerial processes.

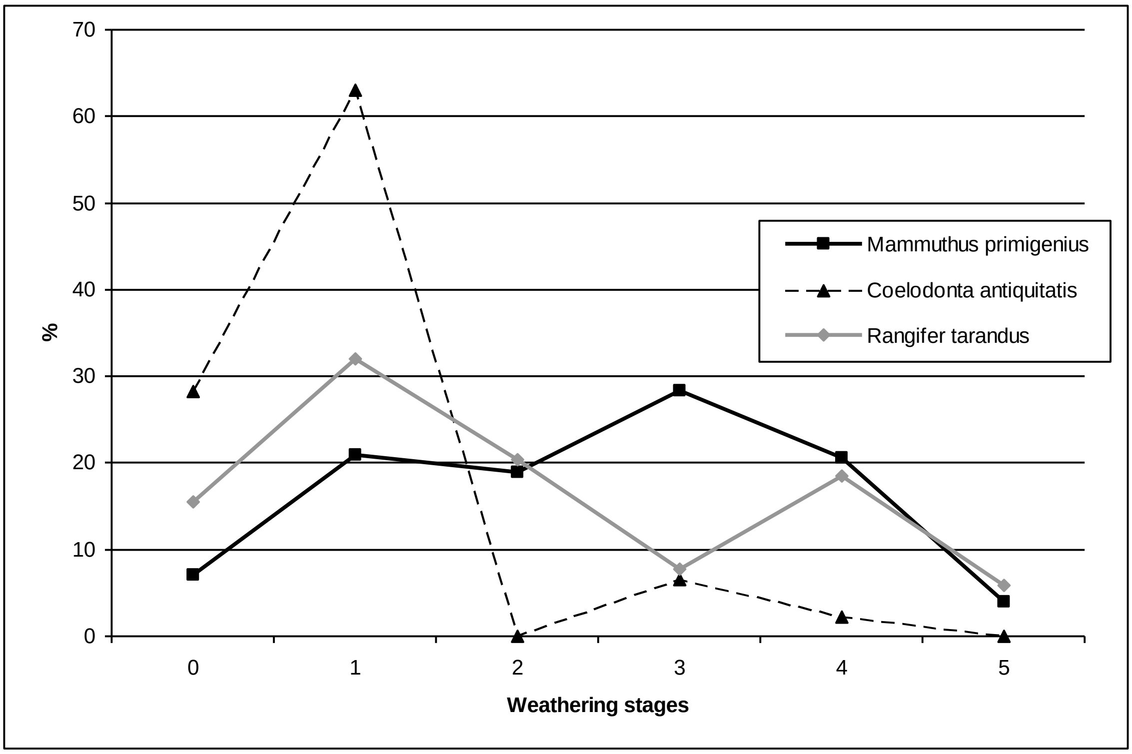

Figure 9.5 Percentage of NISP in each weathering stage in Lynford lacustrine deposits; by species.

9.1.1.3 Terrestrial deposits

Terrestrial deposits were only identified at Boxgrove, with a similar weathering pattern to that identified in fluvial and lacustrine deposits (see Appendix 6 Table 6 and Figure 9.6). Weathering of material from the terrestrial deposits highlight that

85.1% of the specimens had none/limited sub-aerial modification with a smaller proportion of specimens (14.9%) heavily weathered.

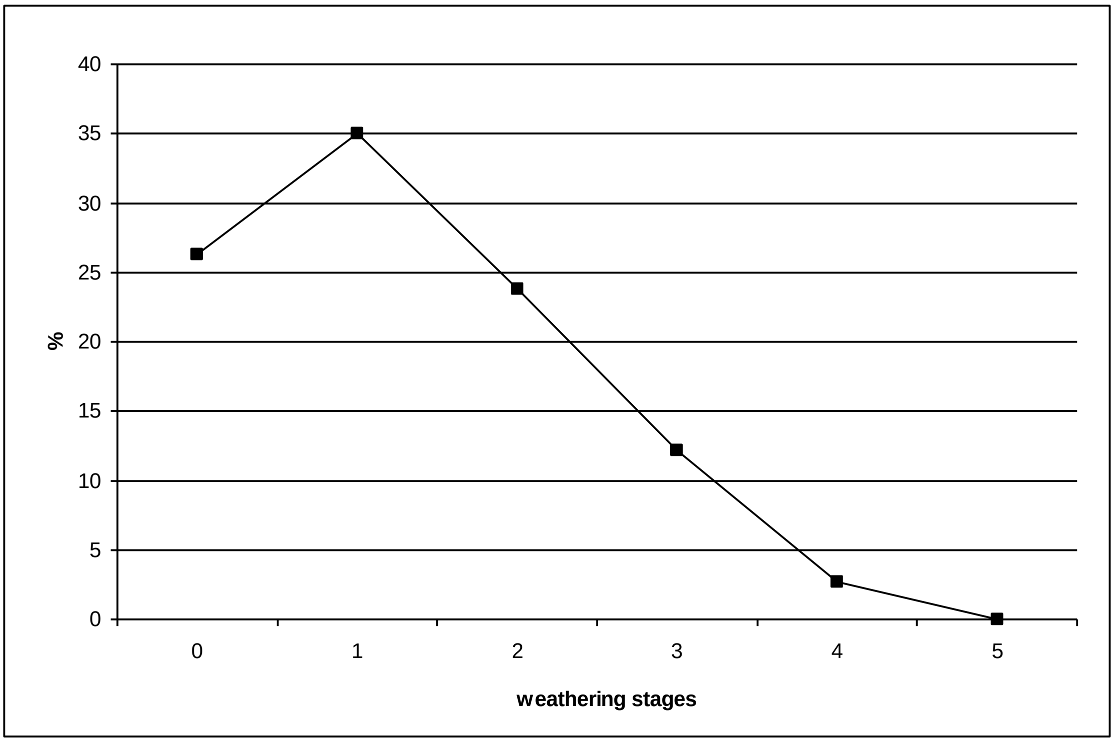

Figure 9.6 Percentage of NISP in each weathering stage from terrestrial deposits at Boxgrove.

The sub-aerial weathering on various large taxa illustrates subtle differences. For example, sub-aerial weathering across horse remains highlights a relatively low percentage of un-weathered/lightly weathered material (16.7%) compared to more heavily weathered material (83.3%). A similar pattern was also identified on other large taxa such as rhino and bison remains (see Appendix 6 Table 7; Figure 9.7).

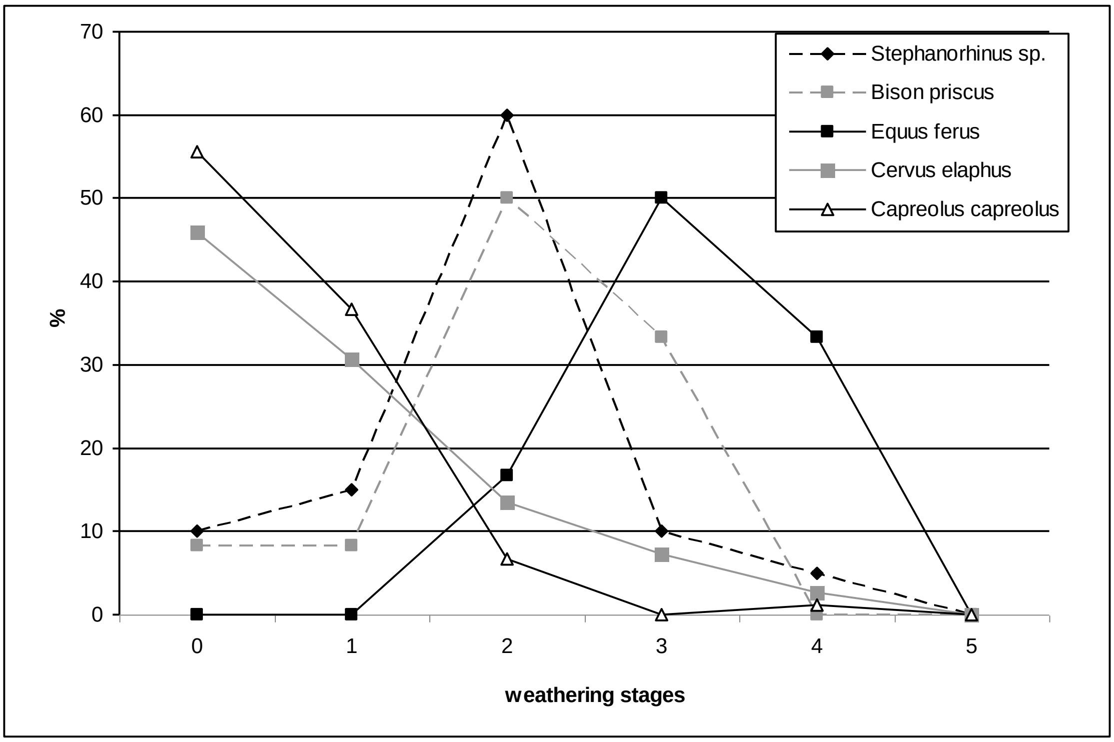

Figure 9.7 Percentage of NISP from each weathering stage in Boxgrove terrestrial deposits; by species.

Such a pattern could be related to the visibility of skeletal elements from these species in the landscape allowing for more intensive processing by hominins and/or other predators (see Section 9.1.2). Alternatively, the isolated butchery-event at GTP 17 may have allowed hominins more time to thoroughly butcher the carcass leaving less meat for other scavenging carnivores. Finally, the pattern may simply be the result of the small number of specimens identified for each species and thus not be an accurate representation of sub-aerial weathering across the terrestrial landscape at Boxgrove. Indeed, the weathering on medium-sized taxa illustrates a pattern similar to that identified on faunal material at other sites and depositional horizons, with 50% of material recorded as un-weathered/lightly weathered indicating rapid burial and limited re-exposure (see Appendix 6 Table 1).

9.1.2 Comparison of large and medium sized taxa

Comparative assessment of deposits from each study site highlights similarities and differences between weathering patterns from different depositional environments. A brief analysis of comparative weathering patterns between large and medium taxa from each site demonstrates that material from Boxgrove, Swanscombe and Hoxne was quickly incorporated into the deposits and suffered limited sub-aerial exposure (Tables 9.2 and 9.3). This variation is most observable through a comparison of cervid species from all four study locations (see Figure 9.8).

		Weathering Stages					
Site	**Species**	**0**	**1**	**2**	**3**	**4**	**5**
Boxgrove	rhino	6 (*15.4*)	14 (*35.9*)	15 (*38.5*)	2 (*5.1*)	2 (*5.1*)	0.0
	horse	27 (*18.6*)	49 (*33.8*)	57 (*39.3*)	9 (*6.2*)	3 (*2.1*)	0.0
Swanscombe	rhino	2 (*16.7*)	6 (*50.0*)	4 (*33.3*)	0.0	0.0	0.0
Hoxne	rhino	13 (*20.0*)	2 (*3.1*)	50 (*76.9*)	0.0	0.0	0.0
	horse	149 (*58.7*)	55 (*21.7*)	40 (*15.7*)	10 (*3.9*)	0.0	0.0
Lynford	mammoth	165 (*7.0*)	490 (*20.9*)	442 (*18.9*)	662 (*28.3*)	488 (*20.8*)	94 (*4.0*)
	woolly rhino	13 (*28.3*)	29 (*63.0*)	0.0	3 (*6.5*)	1 (*2.2*)	0.0
	horse	1 (*14.3*)	4 (*57.1*)	2 (*28.6*)	0.0	0.0	0.0

Table 9.2 NISP recorded in each weathering stage for major large taxa from each study site; figures in parentheses are % of total NISP for each weathering stage.

		Weathering Stages					
Site	**Species**	**0**	**1**	**2**	**3**	**4**	**5**
Box	red deer	174 (*36.3*)	156 (*32.6*)	101 (*21.1*)	32 (*6.7*)	16 (*3.3*)	0.0
	fallow deer	14 (*93.3*)	1 (*6.7*)	0.0	0.0	0.0	0.0
	roe deer	56 (*46.3*)	42 (*34.7*)	21 (*17.4*)	1 (*0.8*)	1 (*0.8*)	0.0
Swans	red deer	5 (*31.3*)	9 (*56.3*)	2 (*12.5*)	0.0	0.0	0.0
	fallow deer	164 (*39.3*)	183 (*43.9*)	64 (*15.3*)	5 (*1.2*)	1 (*0.2*)	0.0
Hoxne	red deer	50 (*47.6*)	42 (*40.0*)	13 (*12.4*)	0.0	0.0	0.0
Lyn	reindeer	16 (*15.5*)	33 (*32.0*)	21 (*20.4*)	8 (*7.8*)	19 (*18.4*)	6 (*5.8*)

Table 9.3 NISP recorded in each weathering stage for major medium-sized taxa from each study site; figures in parentheses are % of total NISP for each weathering stage.

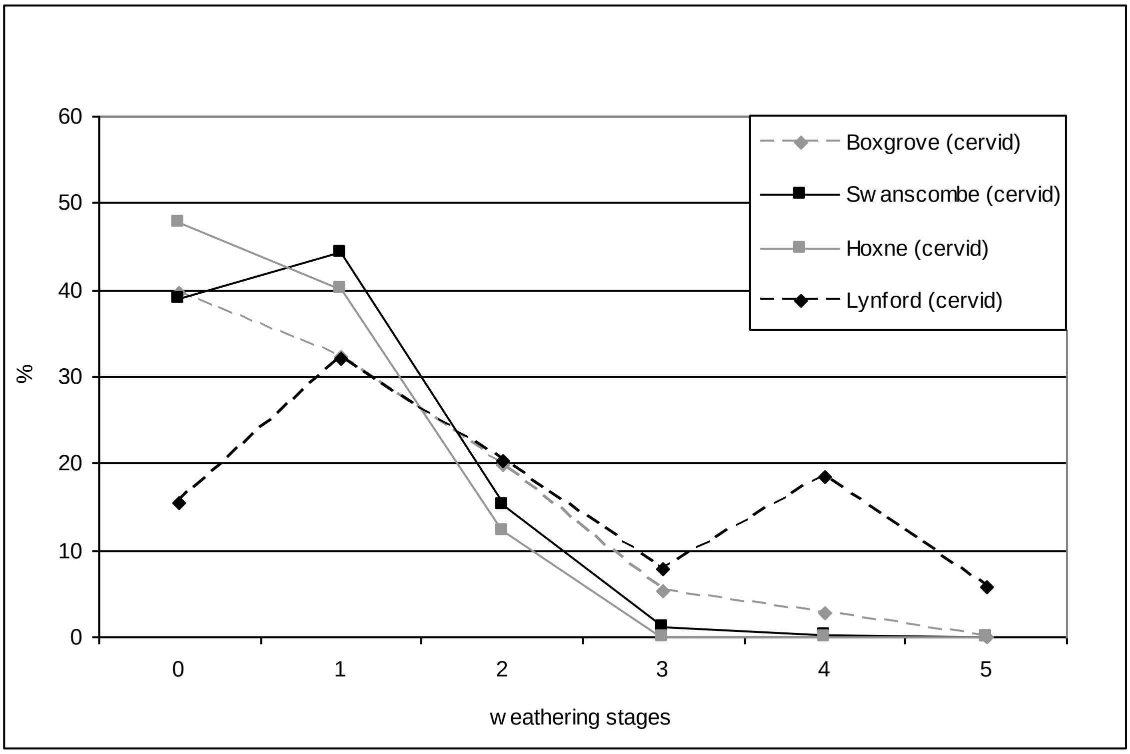

Figure 9.8 Comparison of %NISP from each weathering stages for cervid species from all four sites.

This basic comparison of species from each of the sites complements and supports the evidence from the comparison of faunal material from different depositional environments.

9.1.3 Summary: Inter-site weathering patterns

A comparison of weathering on material from all four study sites has highlighted similarities and differences in the pattern of sub-aerial weathering from different depositional horizons and across taxa of different sizes. A site-based comparison has demonstrated a similarity in weathering at all three Lower Palaeolithic sites, in contrast to the Middle Palaeolithic locality at Lynford. Weathered faunal remains from Boxgrove, Swanscombe and Hoxne have high percentages of un-weathered/lightly weathered material, frequently 80-90% (Appendix 6 Table 1). The high percentage of lightly weathered material suggests limited exposure, and in the absence of heavily weathered specimens little re-exposure. Similar patterns of sub-aerial modification from different depositional horizons at each site and across different taxa corroborate the premise that faunal material was rapidly incorporated into the deposits. Indeed, the absence of heavy weathering on material from fluvial deposits at Boxgrove, Swanscombe, and Hoxne could relate to incorporation and movement within the river channels (see Section 9.1.4; Chapter 5, 7 and 8); the presence of relatively high values for fluvial modification at Swanscombe (16.1%) along with fluvial alignment at Hoxne (Ashton *et al,* 2008), strongly suggests that material recovered at both locations has been significantly modified and disturbed through fluvial processes.

Despite identification of fluvial deposits at Boxgrove the flow regime appear slower than that recorded at Swanscombe and Hoxne. Indeed, it is important to re-emphasise that the river sediments at Swanscombe were deposited by a river with greater flow rate compared to those identified at either Boxgrove or Hoxne. The similarities in weathering and bone surface modifications on remains from both fluvial, lacustrine, and to a certain extent terrestrial deposits make it difficult to determine sedimentary provenance from zooarchaeological material alone. There is a clear equifinality of signatures here that cannot solely be resolved through the use of zooarchaeological data alone. Without prior knowledge of the depositional provenance of these faunal remains could potentially lead to ambiguous interpretations. This potential for equifinality of bone-surface modification signatures emphasises the need for rigorous methodological assessment of zooarchaeological remains using multiple sources of data (Gifford-Gonzalez, 1991).

In contrast, faunal material from Lynford exhibited a more even distribution of sub-aerial weathering on numerous species and within deposits, though just over half the specimens recorded were heavily weathered (51%). Indeed, the variation in weathering across different species and contexts suggests continual deposition of material at the site and also repeated re-exposure. This is probably, in part, related to the return of various animal species to this location causing trampling, disturbance and possible re-exposure; additionally hominin and predator use of carcass resources at the site could also account for some of variation in weathering observed (see Chapter 6; Section 9.1.3). Such reuse of this location could have accelerated natural bank degradation and eventual collapse causing the faunal material to slump into the disused channel (see Boismier, 2003; in press-a; Chapter 6).

9.1.4 Inter-site comparison 2: Excavation and the importance of the depositional environment

> *"Identifying and interpreting the behavioural patterns characteristic of prehistoric hunter-gatherers is one of the main goals of current archaeological research."* (Vaquero, 2008, p3178).

Vaquero (2008) addresses the use of ethnoarchaeological models in archaeological interpretations. Such models often focus on behaviour observed over a relatively short period of time and whilst not invalid, are at odds with the interpretation of material from the archaeological record. This dichotomy between interpretations of behaviour at the short and long time scale is particularly pertinent for analysis of material from Palaeolithic deposits, which could potentially have accumulated over many thousands of years (see also Bailey, 2007).

Using ethnoarchaeological models in Palaeolithic archaeology has resulted in greater focus on specific behavioural events (see Gamble, 1999; Lupo and O'Connell, 2002), without considering the impact of time-averaging on the recovered material. As such the mere identification of modified faunal remains alongside evidence for lithic tool production could be seen to provide cultural confirmation (Stopp, 1997, p4). A more accurate understanding of behavioural signatures uncovered in the archaeological record requires investigation into the biases caused by both on-site depositional environment and excavation techniques employed. Only once these effects have been considered should detailed models of human subsistence be considered and discussed. This is the "tyranny of stratigraphy" (Vaquero, 2008, p3179).

The Swanscombe river channel was the major factor in faunal accumulation, transport and winnowing; the low level of behavioural modifications and higher levels of hydraulic rounding, abrasion and long axis orientation suggests that faunal material was transported considerable distances and submerged for long periods of time (see Table 9.4; see Chapter 7).

Site	Total NISP	NISP fluvial mod	% of total NISP
Boxgrove	1652	38	2.3
Swanscombe	502	53	10.6
Hoxne	492	3	0.6
Lynford	3498	68	1.9

Table 9.4 Total NISP at each site and the total NISP with fluvial modifications and as a % of total NISP.

A comparison of faunal specimen measurements indicates differences in average length and average width (Table 9.5). To test whether the differences in average bone length and width from fluvial deposits at Boxgrove and Swanscombe were significant both descriptive and non-parametric statistical tests were used (see Table 9.6).

Site	Average Length (mm)	Average Width (mm)
Boxgrove	53.7	20.1
Swanscombe	103.8	33.2

Table 9.5 Average length and width of specimens from fluvial deposits at Boxgrove and Swanscombe

The coefficient of variation measures the dispersion of data points in a range around the mean and is a useful statistical test for comparing the degree of variation from one data series to another. When comparing the length and width of faunal specimens from fluvial deposits at both Boxgrove and Swanscombe the values for the coefficient of variation are high (see table 9.6); these high values indicate that the standard deviation is almost as large as the mean which is indicative of a skewed distribution (See Appendix 6 Figures 1 & 2).

	N total	Mean	Standard Deviation	Sum	Coefficient of Variation	Min	Median	Max
Length(B)	167	4.69048	4.64523	783.31	0.99035	0.68	3	33.2
Length(S)	298	10.28349	9.18965	3064.48	0.89363	0.8	8	58.5
Width(B)	167	2.12814	2.15146	355.4	1.01096	0.39	1.58	21.3
Width(S)	298	3.32362	3.55507	990.44	1.06964	0.35	2.5	30

Table 9.6 Descriptive statistics including mean, standard deviation and coefficient of variation for faunal specimens from fluvial deposits at Boxgrove (B) and Swanscombe (S)

These descriptive statistics have demonstrated that these populations do not represent a normal distribution, ruling out more traditional statistical test such as the t-test. Therefore to test the significance of the observed variation in length and width at Boxgrove and Swanscombe non-parametric statistics were used, specifically, Mood's Median Test. This test assess the equality of the median from two or more populations, holding no assumptions about specific distribution; hence the *null hypothesis* that both sets of data are from the same population (see Corder and Foreman, 2009). This test was performed on the faunal material from fluvial deposits at Boxgrove and Swanscombe using the length and width measurements (see Table 9.7). For the “length” the probability was so low that it was rounded to zero whilst the “width” produced a probability of (1.27E-7). At a 0.05 confidence level these populations are significantly different; hence, faunal material from Boxgrove is significantly smaller than that from Swanscombe and the null hypothesis is rejected.

	Site	N	Min	Q1	Median	Q3	Max
“Length”	**B**	167	0.68	2.02	3	5.48	33.2
“Length”	**S**	298	0.8	4.2	8	12.775	58.5
	Median	**Chi-Squared**	**DF**	**Prob>Chi-Squared**			
"Length"	5.7	73.4159	1	0			

Table 9.7 Mood’s median test on faunal material from fluvial deposits at Boxgrove (B) and Swanscombe (S); DF: degrees of freedom

The variation in the size of material recovered from the fluvial deposits at Swancombe and Boxgrove is a reflection of differences in the depositional environment and excavation strategy. The depositional regimes at each of these sites were markedly different, with a high energy fluvial environment and Swanscombe and a lower-energy spring-fed channel at Boxgrove. This difference in fluvial discharge has had a dramatic effect on the preservation of faunal material; the specimens preserved at Swanscombe are larger often denser fragments with other weaker portions winnowed out. In contrast, the material from the channel deposits at Boxgrove illustrates a wider array of both dense and weak elements, more closely resembling skeletal part representation from other deposits at this site. In addition, the excavation strategy and faunal recovery at Swanscombe was coarse and often focussed only on larger, identifiable faunal remains (Currant, *pers comm.*). The absence of a recovery strategy at Swanscombe for both small mammal species and bone fragments represents the inadvertent introduction of bias into the faunal collection. Without the recovery of smaller fragments, as seen at sites such as Boxgrove (see Table 9.5), the assemblage is potentially incomplete and cannot truly be taphonomically assessed. Detailed analysis of the faunal assemblage from Swanscombe has identified statistically significant evidence for fluvial accumulation, transport and modification along with the introduction of bias through excavation recovery and post-excavation sampling.

The same approach was use to test whether the most abundant deer species from each of the study sites[9] showed similar statistically significant differences. Deer was selected because it was recovered from each of the sites and will therefore provide an excellent inter-site comparison. The statistical comparison of deer remains showed no significant difference between the data sets from Boxgrove, Hoxne and Lynford though Boxgrove and Swanscombe were still significantly different (See Appendix 6 Tables 8-11). However, the significance of the comparisons of deer across all sites is limited by the size of the populations from both Hoxne (n=36) and Lynford (n=82) and raises questions about the utility of these comparisons in light of the difference between Boxgrove and Swanscombe.

Demonstrating a statistically significant difference between the assemblage composition at Boxgrove and Swanscombe has important implications for the interpretation of hominin behaviour both at this and other similar sites. Any hominin and predator-scavenger behavioural signatures on faunal material from river sites cannot represent truly *in-situ* behavioural episodes. Indeed, such modifications could potentially have occurred anywhere within the river catchment and as such must be considered as secondary deposits and hence only evidence for hominin presence within the river catchment. Therefore there is insufficient evidence to produce detailed models about hominin meat-procurement behaviour and competition with other carnivore species.

Excavations at Hoxne were more standardised, systematic and thorough compared with those at Swanscombe, which is reflected in the wider range of both large and small mammals species along with other taxa such as fish and amphibians (see Stuart *et al*, 1993). In fact, the range of species recovered is comparable to fossil vertebrates documented from both Boxgrove and Lynford (see Chapters 5 and 6; Roberts and Parfitt, 1999; Schreve, n.d.). The identification of such a broad range of species suggests a more holistic collection strategy and a less skewed faunal assemblage to

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[9] Abundant deer species Boxgrove: red deer; Swanscombe: fallow deer; Hoxne: red deer; Lynford: reindeer.

that from Swanscombe. Recent stratigraphic work at Hoxne identified that most of the faunal material was recovered from a previously undocumented river channel (see Chapter 8 and Ashton *et al*, 2008). Analysis by Parfitt (*pers comm.*; Ashton *et al*, 2008) illustrates faunal long axis alignment to the direction of channel flow. Although there is an absence of hydraulic modification across faunal specimens from the site, such alignment indicates prolonged exposure within the river channel. Indeed, an absence of heavily weathered material from the Hoxne deposits could be used as a proxy indicator for rapid incorporation into a fluvial environment and protection from sub-aerial weathering. Further analysis of the fauna from Hoxne is also limited by the size of the assemblage; whilst the assemblage is less modified by natural agents than sites such as Swanscombe, the assemblage is still too small to indicate unequivocally any single meat procurement event. Whilst faunal assemblages from Swanscombe and Hoxne are small, individual elements demonstrate evidence of hominin modification. Nevertheless, these sites should only be used for coarse comparisons with other sites and cannot, and should not, be used as corroborative evidence for a specific meat-procurement behaviour.

The use of a detailed and consistent excavation methodology at Boxgrove and Lynford has allowed for a detailed excavation record and a high degree of faunal recovery. Previous analysis in this thesis of faunal material from the Boxgrove channel deposits has highlighted limited evidence for fluvial abrasion and shows no long axis alignment to channel flow (see Chapter 5). Indeed sedimentological evidence suggests a slow moving channel and the long axis alignment of faunal material perpendicular to predicted channel flow suggests slumping of material into the channel from the bank edge (see Figure 5.8). This data along with an absence of hydraulically modified material demonstrates that the river channel at Boxgrove had little impact on faunal accumulation and modification; these variations have been shown to be statistically significant.

The large quantity of behavioural modifications on a range of taxa and from different horizons suggests that faunal material accumulated through a combination of hominin and carnivore meat procurement behaviour. In addition, faunal remains from both lacustrine and terrestrial deposits at Boxgrove have similarly high concentrations of modified specimens, 25.9% and 9.03% respectively; though these figures are nowhere near the level identified in the fluvial deposits (see Tables 9.20 & 9.21). It is apparent that despite varied depositional environments at Boxgrove, the faunal material has not been subjected to extensive sub-aerial or erosive processes. The large quantity of hominin and carnivore behavioural signatures identified across numerous species and throughout different contexts suggests that cultural not natural factors were more important in assemblage formation than at any of the other study sites.

The Lynford faunal assemblage was the largest collection studied for this thesis (see Chapter 6). Whilst quantities of predator-scavenger and hominin modifications were comparable to that recorded on fauna from Swanscombe and Hoxne these were still much lower than values from Boxgrove (see Appendix 6 Table 12). Lynford had little evidence for fluvial modification (1.24%) suggesting that faunal material was not brought to the site through river action, as detailed at Swanscombe and Hoxne. The identification of numerous weathering stages reflects a complex set of depositional events was responsible for the accumulation of faunal material at Lynford. The faunal long-axis was aligned with mass flow events suggests an accumulation of material around the lake margins prior to subsequent bank collapse and slumping into the disused channel (Figure 6.4; Boismier, *forthcoming-a*). It could, therefore, be surmised that the faunal material, although not in a truly primary context, was not moved significantly post-deposition. Therefore, any modified faunal material most likely represents hominin behaviour in close proximity to the meander cut-off and such data can be used to discuss Neanderthal meat-procurement strategies at Lynford.

Differences in excavation approach and depositional environment at each study site has resulted in variation in the quality and quantity of both recovered faunal material at each site and the degree of information regarding hominin meat procurement behaviour. The next section will discuss in more detail evidence for hominin meat-procurement behaviour at each site.

9.1.5 Inter-site comparison 3: Hominin behaviour and competition with other predator-scavengers

The introductory chapters to this thesis detailed the continuing debate surrounding evidence of the earliest meat eating in the archaeological record and distinguishing between different meat procurement strategies, such as hunting and scavenging. Each of my study sites were chosen specifically because interpretation of faunal material from each site had previously been used to support a different mode of hominin meat-procurement behaviour. Such interpretations also suggested that hominins played either an active or passive role in both faunal accumulation and modification.

Both predator-scavenger and hominin behavioural signatures were recorded and analysed alongside other site formation processes and against the backdrop of the depositional environment. This methodological approach helped to assess the role and importance of hominin and non-hominin predators as agents of faunal accumulation. Analysis of bone surface modifications identified considerable variation in both quantity and distribution, within and between sites, with only ephemeral evidence for meat procurement behaviour at some locations.

9.1.5.1 Bone surface modifications: Hominins and carnivores

Predator-scavenger and hominin behavioural signatures were identified on bone surfaces from all study sites, but the quantity, intensity and distribution of such modifications vary both within and between the different sites (Appendix 6 Table 12; Figure 9.9). Appendix 6 Table 12 illustrates the total number of specimens analysed for each site alongside the total number of specimens modified by humans (%NISPHM) and predator-scavengers (%NISPPS). Breaking the data down by site highlights that fauna from Boxgrove was more substantially modified, both by hominins and carnivores. Indeed, despite the faunal assemblage recovered from Lynford consisting of almost double the number of specimens compared to Boxgrove, the latter has a larger percentage of modified remains (20.1%) compared to Lynford (3%). Similarly low percentages for modified specimens were recorded at both Swanscombe (3%) and Hoxne (4.1%) and serves to highlight the uniqueness of the preserved fauna from Boxgrove.

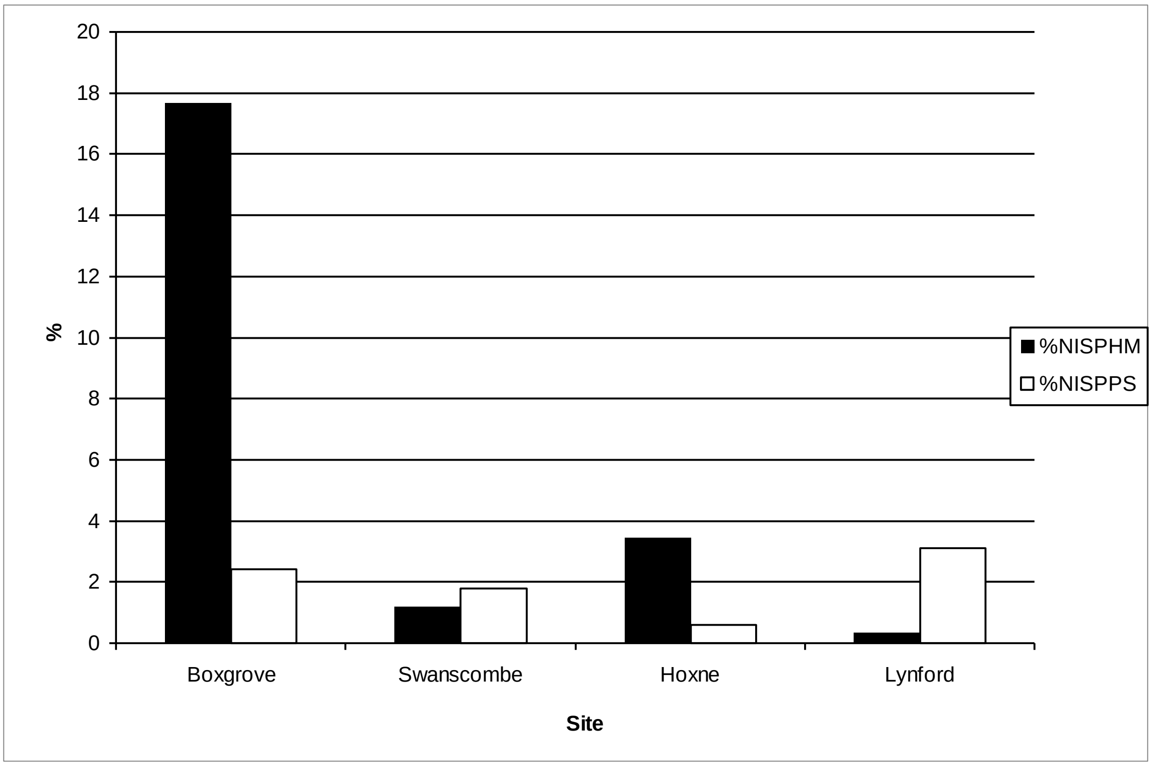

Figure 9.9 Percentage of NISP from each study site modified by humans (%NISPHM) and carnivores (%NISPPS).

The distinctiveness of the modification across the Boxgrove fauna can similarly be highlighted by looking at the quantity of cut marks and humanly-fractured bone (Table 9.8 and 9.9).

Site	NISP	NISPHM	NoCM
Boxgrove	1652	292 (*17.7*)	605
Lynford	3499	12 (*0.3*)	0
Swanscombe	504	6 (*1.2*)	21
Hoxne	492	17 (*3.5*)	49

Table 9.8 Total NISP at each site and NISPHM compared to total number of cutmarks (NoCM); numbers in parentheses are human modifications as a % of total NISP.

Boxgrove has the largest quantity of cut marks recorded from any of the study sites (n= 605) and these modifications are not confined to a particular species but are present across taxa of all sizes (see Chapter 5; Roberts and Parfitt, 1999). In contrast, the faunal material from the other study locations have considerably fewer cut marked specimens, which in turn are not distributed across the same range of species as those identified at Boxgrove (Chapters 6-8). Pertinently, despite a large assemblage size, no cut marks were identified on faunal material from Lynford. Similarly, the number of fractures identifiable to either human or carnivore carcass processing behaviour is high at Boxgrove (69.5%) compared to the other sites studied (Table 9.9). Although the percentages of similarly fractured remains from Hoxne are high, the total number of fractures identified is considerably smaller (n= 7), both in relation to the size of the assemblage and number of specimens modified. Although Swanscombe had one of the smaller faunal assemblages, more fractures were identified on this assemblage than those at either Hoxne or Lynford (Table 9.9). The small number of fractures identifiable to human or carnivore behaviour serves to illustrate the limited role of these agents in faunal accumulation and modification at Swanscombe.

Site	NoFract	NoHF	NoPF
Boxgrove	46	29 (*63.0*)	3 (*6.5*)
Lynford	16	4 (*25.0*)	6 (*37.5*)
Swanscombe	22	1 (*4.6*)	3 (*13.6*)
Hoxne	7	6 (*85.7*)	1 (*14.3*)

Table 9.9 Total number of fractures recorded at each site and numbers attributed to human (HF) or carnivore action (PF); numbers in parentheses are % of total number of fractures for that site.

Separating out hominin and predator-scavenger behavioural signatures emphasizes the differences between Boxgrove and the other study sites, not only in terms of the total quantity of modification but also in the amount of both human and carnivore modification (Table 9.10).

Site	NISP	NISPMod	NISPHM	NISPPS
Boxgrove	1652	332 (*20.1*)	292 (*17.7*)	40 (*2.4*)
Lynford	3499	121 (*3.5*)	12 (*0.3*)	109 (*3.1*)
Swanscombe	504	15 (*3.0*)	6 (*1.2*)	9 (*1.8*)
Hoxne	492	20 (*4.1*)	17 (*3.5*)	3 (*0.6*)

Table 9.10 Total NISP and total NISP modified (NISPMod); Total number of specimens humanly modified (NISPHM) and number of specimens modified by scavengers (NISPPS); numbers in parentheses are percentages.

At Boxgrove, 17.7% of specimens were humanly modified compared to other carnivore modifications (2.4%). Bone surface modifications across faunal material from Hoxne illustrates a similar division between humanly modified specimens (3.5%) compared to other carnivores (0.6%), though the proportions and quantities are substantially smaller. Interestingly, the behavioural signatures recorded on fauna from Lynford are reversed with a predominance of carnivore (2.7%) compared to human modification (0.3%). In contrast, modification of fauna recovered at

Swanscombe highlights an approximate congruence between human (1.2%) and non-human predator (1.8%) behavioural signatures.

Further comparison of bone surface modifications across different sized taxa at each of the study sites highlights similar variation within and between these sites. For example, as Figure 9.10 illustrates (see also Appendix 6 Table 12) large taxa remains from Boxgrove are again more intensively modified by hominins (78%) compared to non-human carnivores (22%), which is in contrast to bone surface modifications recorded on large taxa from Lynford (%NISPHM = 4.7%; NISPPM = 79.1%) but similar to Hoxne. It is important to emphasise that sample size at Hoxne and Swanscombe are significantly lower than either Boxgrove or Lynford.

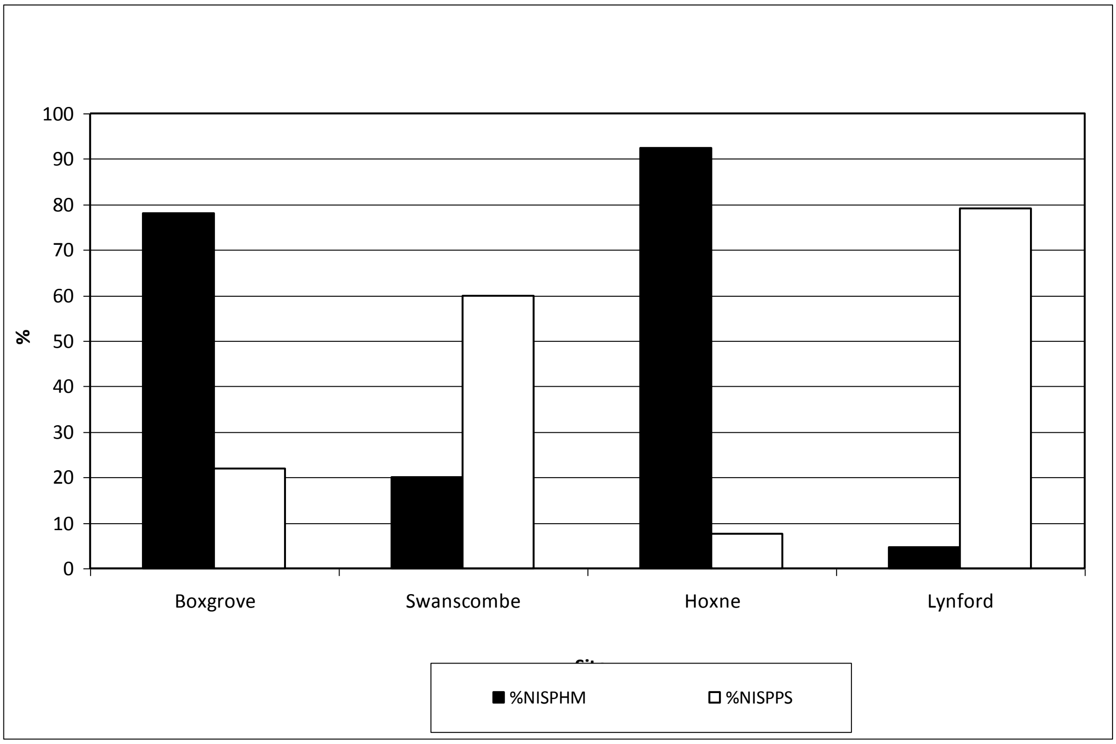

Figure 9.10 Percentage of NISP modified by humans (NISPHM) and carnivores (NISPPS) on large taxa from each site.

A similar pattern of hominin and predator-scavenger modifications was recorded across the medium sized taxa from both these study sites (see Appendix 6 Table 13; Figure 9.11). Boxgrove demonstrates higher concentration of hominin (88.5%) compared to predator-scavenger (9.7%) behavioural signatures; and again at Lynford the modification of medium-sized species contrasts well with the Boxgrove pattern with a predominance of predator-scavenger (68.4%) compared to hominin (31.6%).

The relatively small number of modified medium-sized specimens recorded at Lynford illustrates the dominance of larger taxa, especially mammoth, at the site. The small number of modified medium-sized faunal remains does not suggests preferential selection by hominins, perhaps as a single hunting event, but rather a more *ad hoc* exploitation of resources at this location. In contrast, a greater range of medium-sized species at Boxgrove preserve evidence for hominin modification compared to larger taxa, which could relate to specific hominin prey selection and meat procurement strategies (see Chapter 5; section 9.1.6.).

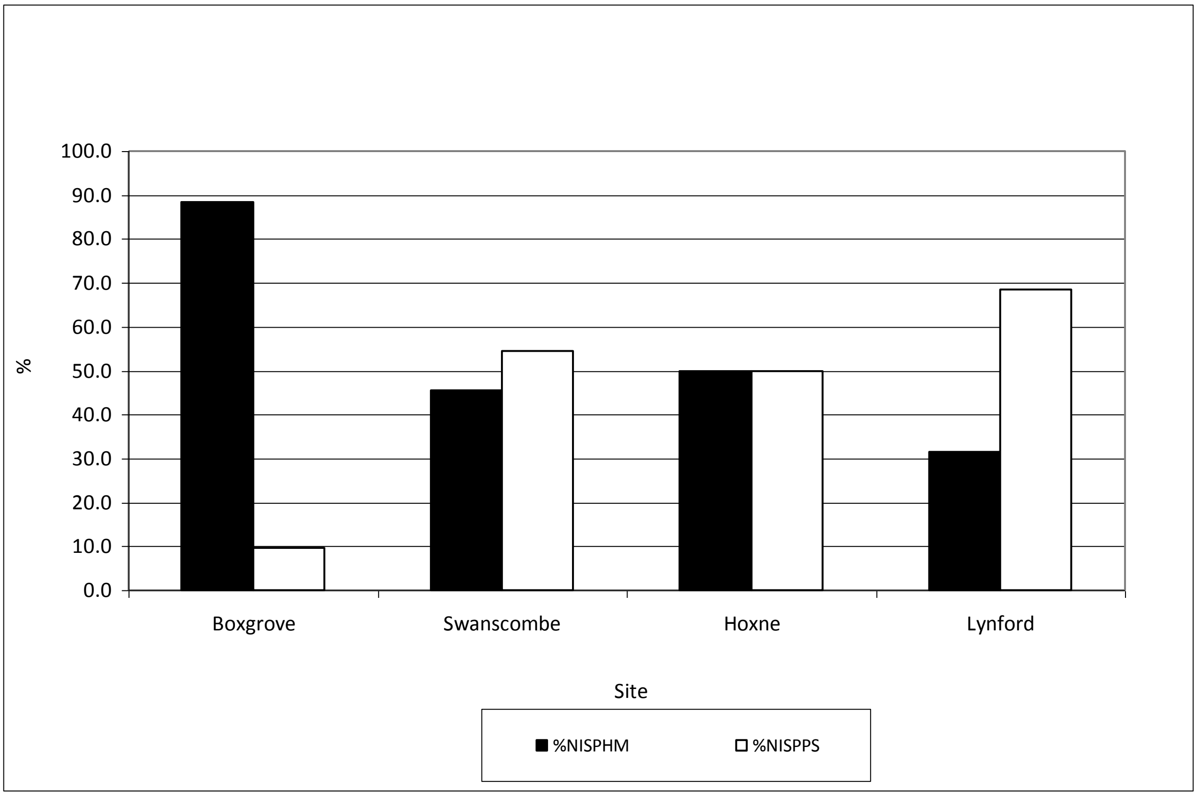

Figure 9.11 Percentage of NISP modified by human (NISPHM) and carnivore (NISPPS); medium taxa from each site.

The quantity of modified faunal from both Swanscombe and Hoxne is roughly congruent for medium sized taxa (see Figure 9.11) A comparison of modified specimens from fluvial deposits at each study site highlights a larger percentage of modified material from the Boxgrove channel deposits (69.4%) compared with both fluvial sequences at Swanscombe (3%) and Hoxne (3.7%) (see Appendix 6 Tables 14-19). As already demonstrated faunal material from the Boxgrove channel deposits has a lower incidence of fluvial modification (2.1%) compared to both Swanscombe (16.1%) and Hoxne (5.3%). The depositional environment at Swanscombe and

Hoxne has resulted in a disturbed faunal assemblage. At both sites the number of modified specimens is small and the behavioural signatures too ephemeral, in relation to other site formation processes, to allow for detailed discussion of hominin and predator-scavenger interaction and meat procurement behaviour.

However, the depositional context and behavioural signatures recorded at Boxgrove and Lynford permit a more detailed discussion of hominin behaviour and interaction with other carnivore species. Indeed, the patterns identified appear to illustrate two distinct behavioural approaches, perhaps as a result of different hominin species, environment, and resource availability.

9.1.6 Fleshing out the bones: Hominin meat procurement behaviour at Boxgrove and Lynford

Previous analysis has highlighted a considerable difference in terms of the quantity and quality of bone surface modification and its distribution across remains from different depositional horizons and species. Of all the sites studied, only the faunal material from Boxgrove was recovered from primary contexts (see Chapter 5; Roberts & Parfitt, 1999). In contrast, the lithic and faunal material recovered from deposits at Lynford has been disturbed by bank collapse and slumping into the meander cut-off. Despite this there is little evidence for fluvial winnowing (1.94%). So, whilst the faunal material from Lynford is not in a truly primary context it has neither been transported vast distances nor suffered significant fluvial modification like the fauna from deposits at Swanscombe and Hoxne. The next section will discuss the variation in bone surface modifications at Boxgrove and Lynford and what this means in terms of hominin behaviour and interaction with other carnivore species.

Behavioural modifications at Boxgrove were recorded across the majority of species studied and throughout the major horizons at the site (Tables 9.11 & 9.12).

Context	Unit 4b		Unit 4c		Unit 5a	
Species	**NISP**	**NISPHMod**	**NISP**	**NISPHMod**	**NISP**	**NISPHMod**
Stephanorhinus sp.	2	0	16	11 (*68.8*)	2	1 (*50.0*)
Megaloceros sp.	6	2 (*33.3*)	0	0	1	0
Bison priscus	7	0	0	0	0	0
Equus ferus	134	53 (*39.6*)	4	0	0	0
Cervus elaphus	51	10 (*19.6*)	137	20 (*14.6*)	105	2 (*1.9*)
Dama dama	0	0.0	4	0	9	0
Capreolus capreolus	16	0.0	70	0	12	0
Indet	116	21 (*18.1*)	49	2 (*4.1*)	27	0

Table 9.11 Human modification at Boxgrove through major contexts and across major species in relation to species NISP; numbers in parentheses are % of total NISP humanly modified (NISPHMod).

Contest	Unit 4b		Unit 4c		Unit 5a	
Species	**NISP**	**NISPPSMod**	**NISP**	**NISPPSMod**	**NISP**	**NISPPSMod**
Stephanorhinus sp.	2	0	16	5 (*31.3*)	2	0
Megaloceros sp.	6	0	0	0	1	0
Bison priscus	7	0	0	0	0	0
Equus ferus	134	12 (*9.0*)	4	0	0	0
Cervus elaphus	51	2 (*3.9*)	137	3 (*2.2*)	105	0
Dama dama	0	0.0	4	0	9	0
Capreolus capreolus	16	0.0	70	0	12	0
Indet	116	2 (*1.7*)	49	1 (*2.0*)	27	0

Table 9.12 Carnivore modification at Boxgrove through major contexts and across major species in relation to species NISP; numbers in parentheses are % of total NISP carnivore modified (NISPPSMod).

The percentage of Hominin modification at Boxgrove is high throughout Units 4b and 4c, ranging from 4.1-68.8%. Unit 5a, however, has a lower percentage of modified specimens, which are distributed across a smaller range of species. Nevertheless, the presence of hominin behavioural signatures in the periglacial deposits of Unit 8 and 11 illustrates a continued, if limited, presence of these populations after the onset of the Anglian glaciation. Hominin behavioural signatures have been recorded across different species ranging from rhinoceros to fallow deer (Tables 9.11 and 9.12). Modifications recorded across all these species indicate the entire range of processing behaviours including skinning, dismemberment, filleting, marrow extraction and removal of brain and offal. Also, various bone surface modification, indicating different carcass processing techniques, were recorded on the same specimen (cf. Figure 5.38). Importantly, where both hominin and carnivore modifications were present on specimens, the former are consistently overlapped by the latter (see Chapter 5). The range of processing behaviour combined with the location on the specimens in relation to other carnivore modifications demonstrates hominins primary access to these carcasses. Indeed, the quantity of modification on some specimens not only indicates evidence for intensive butchery and meat removal but also an ability to keep other scavengers at bay. This latter fact is especially impressive considering the presence of species such as hyaena and lion.

Lithic and faunal material continually accumulated across this landscape throughout the duration of its exposure and refitting across relatively short spatial and temporal distance indicates limited post-depositional disturbance or deflation (see Roberts and Parfitt, 1999; Pope, 2002; Roberts, Pope and Parfitt, (*forthcoming*). Pope (2002, 2005) has distinguished different types of behaviour at varied locations throughout the Boxgrove landscape. Pope (2002) suggests that the portability of tools allowed for movement around the landscape and often deposition at known areas of repeated return, such as the waterhole at Q1/B (Pope, 2002; Roberts *et al*, *in prep*). Conversely, at GTP 17 larger quantities of lithic debitage and an absence of finished tools have been interpreted as a single knapping episode with the subsequent removal of the tools off-site; GTP 17 does provide evidence of discrete, single-episode horse butchery and the puncture wound on the scapula is the clearest evidence for direct hominin involvement at this location (see Figure 5.39; Roberts and Parfitt, 1999; Smith 2003). Hominin bone-surface modification on the horse remains from GTP 17 demonstrates evidence for dismemberment, meat removal and processing for marrow, brain and tongue. On several specimens, hominin modification precedes carnivore modification (cf. Figure 5.34). Such butchery and carcass processing behaviour is indistinguishable from behavioural signatures identified at other points in the Boxgrove landscape; for instance fractured cheek teeth, indicative of marrow extraction from the mandible, have been identified across numerous species at the Q1/B waterhole (Roberts, *pers comm.*).

The lithic and faunal assemblages provide evidence for a single-episode of butchery on a horse carcass at GTP 17; such clear behavioural signatures are unique in comparison to most other Palaeolithic sites. The carcass-processing behaviour at this location is both intensive and holistic, providing a similar pattern to that identified at other locations across the Boxgrove palaeolandscape. The recovery of faunal material at GTP 17 from the inter-tidal deposits (Unit 4b) may have been the most prescient factor at this locale; the environment in front of the cliff would only have been available to hominins, and other animals, during periods of low tide. The incoming tide would undoubtedly have provided the major time constraint for these hominins in terms of both carcass acquisition and butchery. The low incidence of sub-aerial weathering across faunal material from this location demonstrates that faunal remains were buried quickly by inter-tidal deposits after processing by humans. Quick burial by inter-tidal deposits would also explain the limited quantity and distribution of carnivore modification across faunal material at GTP 17. Undoubtedly, lithic and faunal evidence at GTP 17 demonstrates a single episode of butchery; however, variation in lithic discard may have been primarily influenced by the incoming tide rather than representing a distinct hominin behavioural choice related to tool transport and discard.

My analysis has highlighted that the Boxgrove faunal assemblage provides the only unambiguous evidence for hominin primary carcass access and butchery across a variety of species. Such an interpretation complements and supports previous interpretations of hominin meat procurement behaviour at this site (see Roberts and Parfitt, 1999). However, at present the faunal data does not support behavioural models related to structured lithic discard. Whilst my analysis demonstrates clear evidence for hominin primacy in both carcass acquisition and butchery, the data cannot support any current models for hominin landscape use. The prevalence of large quantities of high quality raw material may have predicated any need to conserve raw material; indeed, the capacity for hominins to secure carcasses from large predators such as lions and hyaenas may have provided greater freedom in relation to raw material acquisition and lithic production.

In contrast, my analysis of faunal material from Lynford suggests that Neanderthals played a more limited role in faunal accumulation and modification compared to Boxgrove. All modified faunal specimens were recovered from slow-energy, meander cut-off deposits in Association B-ii (Figure 6.2; Appendix 3 Table 3). Carnivore modification of faunal remains was more abundant than hominin modifications (Tables 9.10). Despite the dominance of mammoth remains in the faunal assemblage no evidence for hominin modification of these elements was identified. Interestingly, carnivore modification was recorded across the entire mammoth skeleton and indicates evidence for both meat removal and marrow-processing (Figure 6.16). The absence of hominin modification could indicate that scavengers had already removed remaining carcass nutrients. In fact, extensive analysis could not identify cut marks on elements from any species, despite the presence of large quantities of stone tools in the same deposit. If Neanderthals had hunted and disarticulated these mammoth carcasses for transport off-site some evidence for cut marks, especially around the joints, pelvis and scapulae, would be expected; perhaps similar to the heavily cut marked rhino remains from the Boxgrove Q1/B waterhole deposits. The absence of such a large quantity of hominin butchery marks on the mammoth remains is particularly interesting considering the extensive evidence for predator-scavenger modification on all species and recovery of hominin marrow fracturing on other species (including woolly rhino).

Nevertheless, other forms of hominin modification were identified on other species; these modifications resulted from the processing of long bones and mandibles for marrow (cf. Figures 6.31, 6.39, 6.45). Unlike Boxgrove, carnivore bone surface modifications are overlain by hominin behavioural modifications, suggesting Neanderthals had secondary access to some carcasses (see Figure 6.43). There is no evidence for hominin meat removal from elements of any species. Such distinctiveness in processing behaviour suggests that either the muscle packages had already been entirely removed or were insufficient for the needs of these populations. A focus on carcass products such as marrow, tongue and brain, combined with overlapping bone surface modification signatures, certainly reflects secondary access by hominins; however, such data could also reflect a greater focus on these more fatty resources in light of the more seasonal, and at times, harsher environmental conditions (see Chapter 4 and 6). The dramatic variation in winter and summer temperatures postulated for Lynford (-10°C to 15°C) could have resulted in the freezing of the lake, thus protecting the faunal material from sub-aerial processes and preserving the skeletal elements for hominins and other predators to exploit during the warmer summer months (see Chapter 6; Section 9.1.3).

Although at first glance hominin meat procurement strategies at both Boxgrove and Lynford appear different, there are more subtle similarities. Detailed faunal analysis suggests a more passive meat-procurement approach by Neanderthals at Lynford, which is in contrast to more active meat procurement behaviour at Boxgrove. The absence of evidence for active meat procurement behaviour by hominins at Lynford alongside information on natural modification, particularly weathering data, and mammoth age and sex indicates the attritional accumulation of faunal material at this location (Coope, *in press*; Lister, *in press*). The exploitation of resources at Lynford demonstrates a degree of behavioural flexibility by these Neanderthal populations. The discard of complete lithic tools along the margins of the meander cut-off at Lynford could be viewed in similar terms as the lithic discard pattern from the Q1/B waterhole at Boxgrove (see Pope, 2002). Perhaps the mint condition tools represent deposition by Neanderthal groups at locations where known animal resources were available. The absence of sufficient flint resources on-site means that raw material was brought to the site. The absence of the primary reduction sequence and the presence of completed tools suggests that tools were being brought to the site pre-prepared (Emery, *pers comm.*; Wragg-Sykes, *pers comm.*). Such similarities in lithic discard behaviour could be used to argue for the deposition of lithics at a known locality, enabling both Neanderthal and *Heidelbergensis* populations to have a degree of behavioural flexibility. Certainly for Neanderthals at Lynford, where good quality raw material was evidently absent, this approach could have provided a adaptable approach that meant tools were already available at this location and not necessitating a separate trip to procure raw material.

The slumping of material into the lake from surrounding margins and animal disturbance through trampling has blurred any associations that existed between the lithics and fauna. My analysis of the Lynford fauna suggests an attritional accretion of material throughout the duration of the site; such accumulation conditions should also be considered for lithic material from the site. Whilst structured discard could explain the presence of lithics at Lynford, it is also possible that such tools accumulated slowly, potentially at a rate of one tool per year/season. The identification of dung and carrion beetles along with carnivore coprolites suggests that this location was not a safe locality for medium-long term habitation. Clearly the lithics were left at this location, but whether this relates to a conscious decision or accidental loss is unclear. Such a complex taphonomic scenario was also present around the margins of the Boxgrove waterhole; however, the presence of so much high-quality raw material nearby perhaps negated the need for either lithic caching or structured discard.

Whilst the social context of butchery and meat-procurement requires further research, the behaviour exhibited at both Lynford and Boxgrove suggest that hominins were top predators; their meat-procurement strategies were flexible and adaptable to different environmental conditions. Both these sites represent ends of the spectrum in regard to carcasses access and specific hominin behaviours. Neither meat procurement approach is less primitive. Instead analyses of both faunal assemblages illustrate the development of meat procurement strategies based upon a detailed knowledge of the resource environment. The previous sections have distinguished between each of the study sites and demonstrated the importance of both the depositional environment and excavation history when assessing hominin behaviour at Palaeolithic localities. The next stage is to broaden this discussion of hominin meat procurement behaviour and discuss my findings in light of analysis elsewhere in Europe.

9.2 Britain in context: European data

At present Britain's geographical status is an island off the north-west coast of the European peninsula; this status has shifted periodically throughout the Pleistocene in response to changes in sea level (Preece, 1995; White and Schreve, 2001). Such changes would have allowed land access to Britain during low sea level events. Such a barrier would have prevented the migration of animals, including hominins, and perhaps also prevented the flow of social and technological ideas between Europe and Britain. Nevertheless, there would undoubtedly have been contact between these regions, in terms of technology and social ideas which would, in turn, have influenced subsistence behaviour. Therefore, it is essential to view Britain within the context of meat-procurement strategies and behaviour from the European continent.

The next section will compare results from Lynford and Boxgrove with published data from other Lower and Middle Palaeolithic sites. These sections will focus on detailed comparisons between the Lower Palaeolithic sites of Schöningen and Boxgrove and Middle Palaeolithic sites of La Cotte de St Brelade and Lynford.

Further comparative details will be drawn out from other sites such as Biache-Saint-Vaast and Wallertheim to place data from British sites into a European context. Each of these sites has large faunal collections that were analysed using modern techniques and recorded in great detail. In addition, faunal assemblages from each of these European localities have been interpreted as representing specific evidence for different types of Palaeolithic meat-procurement behaviour.

9.2.1 Lower Palaeolithic meat-procurement behaviour at Schöningen and Boxgrove

Since 1983, monitoring and rescue excavations have been undertaken at the site of Schöningen, located on the former frontier between East and West Germany. Excavations recovered large quantities of lithic and faunal material along with wooden implements interpreted as javelins (Thieme, 1997; Voormolen, 2008); these remains were deposited alongside a former shallow-water lakeshore and dated to c350-300kya (Voormolen, 2008). One of the richest locales was Schöningen 13II-4 where eight wooden spears were recovered alongside a large lithic assemblage, composed of scrapers and retouched flakes, and over 25,000 faunal remains (Voormolen, 2008). The identification of cracked and coloured earth that parallels the find scatters and lake edge, along with burnt wood and bone suggests the presence of fire (Voormolen, 2008). This section will now compare faunal material from Boxgrove and Schöningen to identify any similarity in hominin meat-procurement behaviour and butchery practices.

The fauna from Schöningen is dominated by horse remains (94.8%) that correspond to an MNI of 19; these MNI counts are greater than any reported at the sites studied for this thesis (Table 9.13). Voormolen (2008) cautions against the conventional assumption that faunal accumulation was the result of a catastrophic event because of the unknown time depth represented by these deposits; however, there is evidence to support the idea of a “limited time-spaced depositional event” (Voormolen, 2008, p206). He suggests that the sedimentary environment at the site was relatively stable and covered the material quickly, accounting for limited sub-aerial weathering across the faunal assemblage (Table 9.14)

	Schöningen		Boxgrove	
Species	**NISP**	**MNI**	**NISP**	**MNI**
Horse	2809	19	145	3
Deer	60	2	619	1-3
Bovids	92	2	19	1

Table 9.13 Comparison of NISP and MNI values for major taxonomic groups at Boxgrove and Schöningen

A comparison of weathering data at Schöningen with that from Boxgrove highlights a similarly excellent preservation of bone surfaces; indeed, despite the identification of varying depositional conditions at Boxgrove, patterns of bone weathering indicate rapid burial and limited post-depositional movement or disturbance (see Table 9.14).

Site	Group A[10] (%)	Group B (%)
Schöningen	97	2.7
Boxgrove	89	11
Swanscombe	97.9	2.1
Hoxne	97.4	2.6

Table 9.14 Percentage of faunal material in weathering groupings from different Lower Palaeolithic sites

Taphonomic analysis of faunal material from Schöningen has highlighted similar *in-situ* deposition and rapid burial of horse remains along the lake margins (Chapter 5). This pattern contrasts with the taphonomic evidence from faunal remains in lake-sediments at Lynford that exhibit variation in exposure time indicative of deposition and disturbance over a prolonged period of time (Appendix 6 Table 3). At least 35 instances of horizontal and vertical bone refits provide further supplementary evidence to suggest a fairly rapid burial with limited post-depositional disturbance (ibid). This figure corresponds to approximately 1.25% of the total Schöningen assemblage with a comparable quantity of refits (3%) identified between faunal elements at Boxgrove (see Table 9.15; Chapter 5; Roberts & Parfitt, 1999).

Site	NISP	Refits	%refits
Schöningen	2809	35	1.3
Boxgrove	1652	51	3.1
Swanscombe	504	14	2.8
Hoxne	492	1	0.2

Table 9.15 Number of refits from each Lower Palaeolithic site as a percentage of total NISP.

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[10] Relates to Voormolen's (2008) categories Group A= stages 0-2; Group B= stages 3-5

Whilst faunal remains from Swanscombe and Hoxne preserved evidence of hominin butchery behaviour, sedimentary and depositional conditions prevented more detailed discussion and comparison of meat-procurement behaviour. In contrast, faunal analysis at Boxgrove demonstrates clear and unequivocal evidence of hominin meat-procurement behaviour. The traces of hominin butchery previously documented and discussed for Boxgrove (see Section 9.1.4; Chapter 5) are similar to those highlighted at Schöningen (Voormolen, 2008).

The total quantity of modification recorded across both assemblages is high (Boxgrove = 20.1%; Schöningen = 39%), relative to other Palaeolithic sites including the three other sites studied for this thesis (Table 9.16). Such high levels for modification at both sites, in combination with evidence for limited weathering and post-depositional damage indicates *in-situ* deposition and burial of faunal material into the deposits at both sites. The depositional conditions at both sites allows for a more detailed discussion and comparison between each site specifically focussed on hominin behaviour and interactions with other non-hominin carnivores.

Site	**NISP**	**NISPHM**	**NISPPS**	**NISP HFract**	**NISP PFract**
Schöningen	2809	642 (*22.9*)	456 (*16.2)*	423 (*15.0*)	unknown
Boxgrove	1652	292 (*17.7*)	40 (*2.4*)	29 (*2.0*)	3 (*0.2*)
Swanscombe	504	6 (*1.2*)	9 (*1.8*)	1 (*0.2*)	3 (*0.6*)
Hoxne	492	17 (*3.5*)	3 (*0.6*)	6 (*1.2*)	1 (*0.2*)

Table 9.16 Percentage of human and carnivore modifications and fractures from Lower Palaeolithic sites; numbers in parentheses are % of total NISP; Humanly modified (NISPHM), Carnivore modified (NISPPS), Humanly fractured (NISPHFract), Carnivore fractured (NISPPFract).

The frequency of hominin butchery signatures is greater than other predator-scavenger signatures at both Boxgrove and Schöningen (Table 9.17). At both sites, hominin butchery-traces are overlain by non-carnivore modifications with a higher percentage of hominin compared to carnivore modifications (Table 9.17; Chapter 5).

Site	Boxgrove		Schöningen	
Species	**%NISPHM**	**%NISPPS**	**%NISPHM**	**%NISPPS**
Elephant				
Rhino	79.2	20.8		
Bovids	77.8	22.2	32.6	9.7
Horse	76.4	23.6	22.9	16.2
Deer	88.5	9.7	16.6	20

Table 9.17 Percentage of human (NISPHM) and carnivore (NISPPS) modification across different species from Boxgrove and Schöningen

As illustrated by Figure 9.12 and Figure 5.35 hominin modification of faunal remains at both sites were recorded across most of the skeleton. Some specimens, especially meat-bearing long-bones, preserve evidence of an entire butchery sequence including signatures for skinning, dismemberment and filleting (Figure 9.12). There is evidence for intensive butchery at Schöningen, which is a pattern mirrored at Boxgrove throughout all deposits and across all species. There is a similar absence of horse phalanges at both Boxgrove and Schöningen, which cannot be explained through either density-mediated loss or carnivore destruction. As discussed previously, the absence could relate to the disarticulation of the phalanges from the metapodials to facilitate skinning and allow for the removal of a more complete hide from the carcass. An important avenue for future research should investigate whether such an absence can also be identified at other Palaeolithic sites of a similar age to Boxgrove and Schöningen.

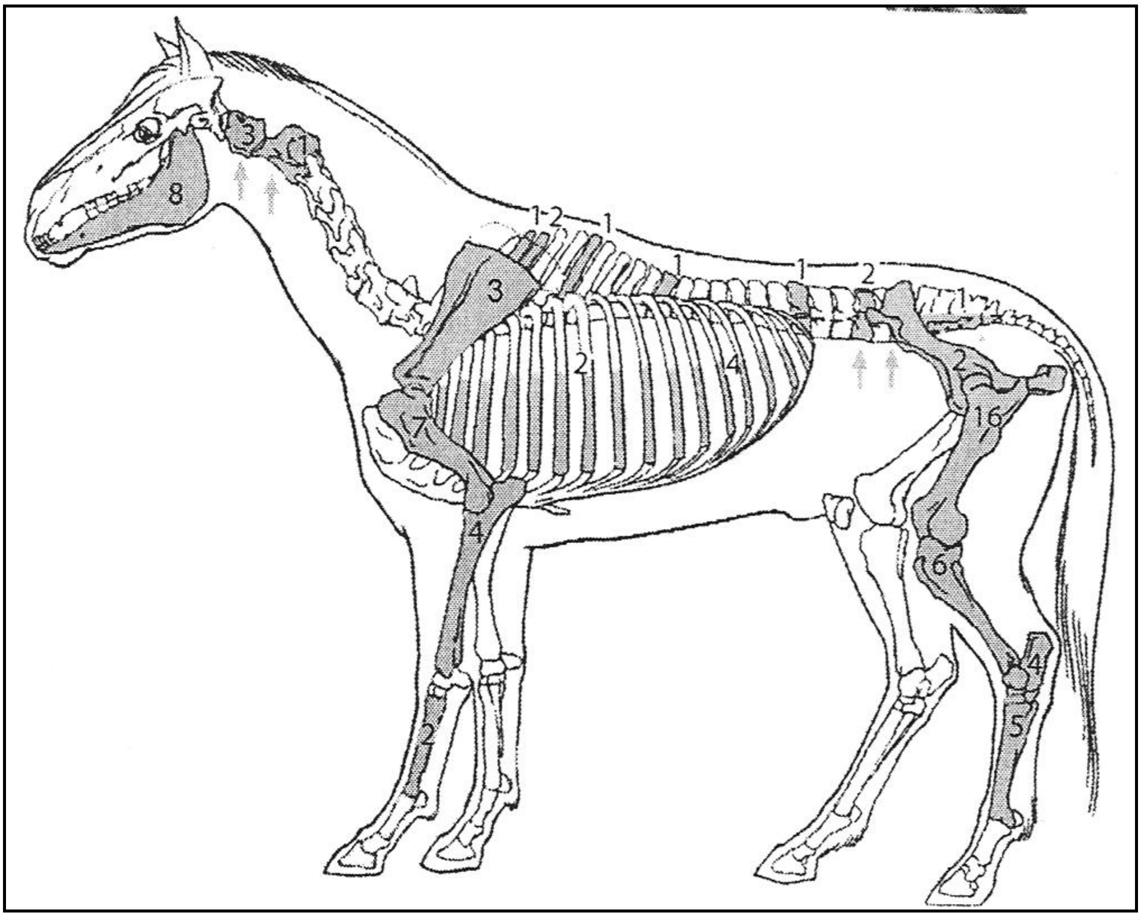

Figure 9.12 Comparison of horse MNI values and cut-marked elements from Schöningen (from Voormolen, 2008, Figure 2.5.44); compare with Figures 5.31 & 5.32.

Alongside evidence for intensive processing of long-bones for meat, both Schöningen and Boxgrove demonstrate further evidence of an extensive exploitation of bone marrow (Table 9.16). Hominin marrow-processing signatures were recorded on 15% of bone specimens at Schöningen; whilst figures for hominin marrow-processing are smaller at Boxgrove (2%), this figure is still higher than recorded for other predator-scavenger fractures (0.2%). Voormolen (2008) has argued that the high incidence of marrow-fractured elements on prime-age adults rather than juvenile individuals is evidence for a systematic and standardised approach to marrow-processing. Whilst this hypothesis cannot be tested for Boxgrove, the evidence presented here suggests that marrow processing was as important as meat to these hominin groups.

Bone surface modifications on faunal material from Boxgrove and Schöningen provide substantial proxy evidence for human primacy at carcasses. However, the recovery of wooden implements from Schöningen, interpreted as projectiles, suggests more active meat procurement behaviour by these hominin groups (Voormolen, 2008). Further complementary evidence to support more active meat-procurement behaviour by *H. Heidelbergensis* populations has been identified through the analysis of faunal material from Boxgrove and Swanscombe (see Chapters 5 & 7). Both of these sites preserved evidence for projectile damage in the form of puncture wounds on the scapulae of a horse (Boxgrove) and fallow deer (Swanscombe) (see Figures 5.39 & 7.10). The damage sustained by these wounds would have been massive and almost certainly fatal given the location of the animal’s major organs. Despite the evidence for active procurement and butchery by hominin groups a fundamental question still remains unanswered: how did these pre-modern human groups hunt and bring down their prey?

This question is especially pertinent to ask at this point when drawing comparisons between Boxgrove and Schöningen. Whilst there are similarities between both sites, there is also considerable variation, most notably in the number of species targeted at each site. This variation may in part be due to differences in scale, with Boxgrove providing a snapshot of part of a landscape, whilst Schöningen provides a brief glimpse of one point on a now lost land-surface. Nevertheless, it is important to consider these variables especially considering that many of the species discussed inhabit different environments; for instance, wild horse are grassland animals whilst deer, which is a prominent species at Boxgrove inhabit the margins between woodland and grassland. The ability to seemingly adapt procurement behaviour to tackle prey within different environments and niches demonstrates a level of behavioural modernity, even amongst these earliest groups.

However, horses are a strong and fast moving species not easily intercepted, and even though the wooden spears, similar to those discovered at Schöningen, could have mortally wounded these animals they first had to be cornered and caught. Levine (1999) suggests that the most suitable method for capturing horses would be through ambush or corralling of multiple individuals. Thus, the spears could have been used to wound the animals before waiting for them to expire through exhaustion, similar to modern !Kung San pursuit hunters (Lee and Devore, 1968). Alternatively if groups of horses, or other animals, were returning to a known location such as a waterhole or lakeshore (as at both Boxgrove and Schöningen) then this would have presented the opportunity to track and surprise a larger group. The ambushing of a group of horses at a known location, such as a waterhole, would have allowed hominins to exert greater control over the flight response of these animals. Voormolen (2008) has suggested this as an explanation for the presence of multiple horse individuals at Schöningen, which includes foals. Such an interpretation could potentially offer an explanation for the large lithic and faunal accumulations around the Q1/B waterhole locality (Roberts, Parfitt and Pope, *in prep*). This explanation cannot, however, account for the isolated behavioural event identified at GTP 17. All evidence demonstrates primary access and butchery by humans whilst the extensive impact damage suggests the animal could also have been severely wounded. It is possible that GTP 17 represents the end of a pursuit hunt that started with the animal being ambushed near a known location and chased until it eventually collapsed and died. GTP 17 could therefore represent evidence of hominin failure to kill this individual at the original intercept point. If so, this would demonstrate flexible meat-procurement behaviour, capable of adapting to variations in prey-flight response and an ability to track and secure the carcass across a wider landscape.

Both Boxgrove and Schöningen have demonstrated evidence for primary butchery and access to carcasses and the ability of hominins to tackle prey of various sizes and environmental niches. Perhaps the strategies employed at both sites represent the precursor to specialised, medium-sized, hunting-behaviour at sites such as Wallertheim and Biache St-Vaast (Conard, 1999; Farizy *et al.*, 1994; Gaudzinski, 1992, 1995, 1999, Grayson and Delpech, 1994; Tuffreau and Somme, 1988).

Wallertheim is an open-air Middle Palaeolithic site located 25km southwest of Mainz, Germany (Gaudzinski, 1995). Lithic tools and faunal remains were recovered from fluviatile deposits of the Wiesbach stream. Palaeomagnetic studies indicate that these sediments were deposited during the Blake Event (108-114kya) (Gaudzinski, 1992). Biache-Saint-Vaast is another open-air Middle Palaeolithic site located in northern France with both fluviatile and loessic deposits. These deposits have yielded Middle Palaeolithic tools and a faunal assemblage more indicative of a warm stage climate. The age of the site is tentatively dated to oxygen isotope stage 7, though this date is still the subject of ongoing debate (Tuffreau and Somme, 1988; Voormolen, 2008).

Comparison of NISP and MNI values from these sites illustrates a potential shift in the focus of hominin populations from a more generalised meat procurement strategy towards a species-specific strategy (Table 9.18).

Site	Boxgrove		Schöningen		Wallertheim		Biache	
Species	**NISP**	**MNI**	**NISP**	**MNI**	**NISP**	**MNI**	**NISP**	**MNI**
Elephant	1	*1*						
Rhino	39	*2*			12	*1*	75	*3*
Bovids	19	*1*	92	*2*	1627	*59*	207	*15*
Horse	145	*9*	2809	*19*	628	*14*	62	*9*
Deer	631	*9*	60	*2*	63	*3*	58	*9*
Bear	26						75	*4*

Table 9.18 Comparison of NISP and MNI values from European Lower and Middle Palaeolithic sites

At Boxgrove a wide representation of faunal species have been recovered with evidence for hominin meat-procurement behaviour. At both Boxgrove and Schöningen there is evidence for intensive, systematic exploitation of marrow alongside other carcass processing behaviour. This is not only prevalent on long bones but across other marrow-bearing elements and in particular this can be highlighted by fracturing of the mandibles (see above; Chapter 5).

In contrast, the number of individuals at the Middle Palaeolithic sites illustrates a narrowing of dietary breadth with a significant focus on such as bovids (Table 9.18). Additionally, the quantity and distribution of cut-marked elements at both Wallertheim and Biache is considerably reduced in comparison with the Lower Palaeolithic localities (Table 9.19).

Site	Boxgrove		Schöningen		Wallertheim		Biache	
Species	**%NISPHM**	**%NISPPS**	**%NISPHM**	**%NISPPS**	**%NISPHM**	**%NISPPS**	**%NISPHM**	**%NISPPS**
Elephant								
Rhino	79.2	20.8						
Bovids	77.8	22.2	32.6	9.7	6.0		0.5	
Horse	76.4	23.6	22.9	16.2		1.75		
Deer	88.5	9.7	16.6	20				
Bear	3.6						5.3	

Table 9.19 Percentage of human (NISPHM) and carnivore (NISPPS) modified specimens on numerous species and various European Palaeolithic sites

The frequency of cut marks across faunal remains from Wallertheim and Biache is “low and hinders [further] systematic study” (Gaudzinski, 1999). At Biache the small number of cut-marked specimens provides evidence for hominin skinning, defleshing, dismemberment and marrow processing on both bovids and bears (Figure 9.13). There appears to be a concurrence in behaviour relating to exploitation of bear at both Boxgrove and Biache with skinning marks identified across the skull and metapodials along with evidence for meat and marrow exploitation; certainly at Biache the cut-marked and fractured remains are consistent with other species exploited by hominins (bovids) at this site. At Boxgrove the small number of bear individuals perhaps suggests that these carcasses represent a more opportunistic discovery related to the natural death of individual animals (for more details see Parfitt, 1999).

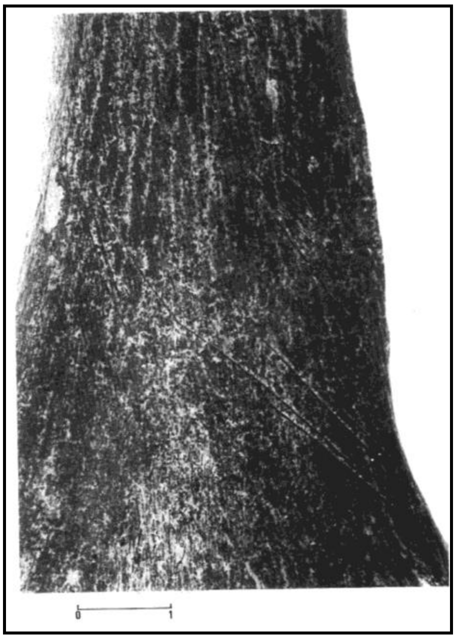

Figure 9.13 Cut marks on distal tibia of bear from Biache Saint Vaast (from Tuffreau and Somme, 1988, Fig 16.16).

Without such direct cut-mark evidence at Wallertheim researchers have focussed on less direct evidence; specifically, the relationship between long bone epiphyses and shafts along with deliberately fractured elements (Gaudzinski 1992, 1995, 1999). A comparison of remains from Wallertheim illustrates that bison remains include a greater proportion of shaft to articular portions, a pattern that is reversed in horse. The survival of horse elements is similar to carnivore-ravaged assemblages identified by authors such as Binford (1981). Further evidence for a difference in accumulation history relates to the distribution of hominin and carnivore modification signatures. Horse remains at Wallertheim only preserve evidence for carnivore modifications whilst hominin butchery signatures were only identified on bison remains.

Gaudzinski (1995, 1999) interprets the differences in accumulation history and bone survival, coupled with bone surface modifications, as evidence that bison remains represent accumulation through specialised hominin-hunting.

Both Biache and Wallertheim demonstrate similarities and differences in hominin butchery-behaviour compared to the Lower Palaeolithic sites of Boxgrove and Schöningen (see Gaudzinski, 1992; Tuffreau and Somme, 1988). Comparative data appears to show a narrowing of focus by hominin populations from the earliest site at Boxgrove; quantification of MNIs clearly illustrates that at Schöningen, Biache and Wallertheim hominins were beginning to focus on a single species. The cut mark modification recorded at Boxgrove and Schöningen is extensive and these figures are lower across fauna from Biache and Wallertheim. A common factor at all of these sites is the emphasis on marrow, exploited not only from long-bones but other regions such as the mandible. Whilst there are differences, it is possible to suggest that the evidence discussed above illustrates a development in human-hunting behaviour. At Boxgrove hominins had the capacity to secure and butcher a wide variety of species, utilising techniques such as ambush and possibly persistence hunting. At Schöningen there is clear evidence for more specialised ambush-hunting that was subsequently refined throughout the Middle Palaeolithic. The evidence from both Schöningen and Boxgrove demonstrate that hominin groups at these locations were efficient and competitive predators. Both sites display evidence for systematic and standardised butchery focussing on a holistic use of carcass resources. Both sites present serious questions regarding the validity of behavioural models that suggest a more marginal, scavenging strategy for Lower Palaeolithic hominins. What appears certain is that by 500,000 years ago hominins were proficient hunters, butchers and competitors; “The co-occurrence of wooden spears with the butchered horse remains [at Schöningen] seems no coincidence” (Voormolen, 2008, p234).

9.2.2 Middle Palaeolithic meat-procurement behaviour at La Cotte de St Brelade and Lynford

La Cotte de St Brelade is situated on the south-west coast of Jersey and its close proximity to the French coastline would have changed in relation to rise and falls in sea level; during interglacials the site would have been cut off from the mainland, much like it is today; the onset of glacial conditions would have resulted in a sea level drop with Jersey initially become a peninsula and then at the height of low sea level, a rocky outcrop on the exposed coastal plain (Scott, 1980). The site itself is a fissure which is partially covered at the western end by an arch with the major archaeological deposits dated to c80-100kya based on uranium-series dates.

Systematic excavations were carried out on deposits beneath this arch by McBurney during the 1960s and 70s (Callow and Cornford, 1986). These excavations yielded large quantities of Middle Palaeolithic tools within deposits containing cool stage fauna (mammoth, woolly rhino, reindeer). Although lithic and faunal material was recovered throughout the sedimentary sequence, the largest quantity of material was recovered from two loessic levels (3 and 6). Within these deposits the fauna is almost exclusively dominated by mammoth (52.1%) and woolly rhino remains (27.9%) (Table 9.20).

Site	**La Cotte**		**Lynford**	
Species	**NISP**	**MNI**	**NISP**	**MNI**
Mammoth	349	*11*	2341	*11*
Rhino	187	*3*	46	*1*
Bos/Bison	11	*1*	4	*1*
Giant deer	2	*1*		
Horse	85	*4*	7	*1*
Red deer	28	*2*		
Reindeer	8	*1*	103	*2*
Grand total	670		2501	

Table 9.20 Comparison of NISP and MNI values for Lynford and La Cotte

These two horizons have been interpreted as evidence of separate events where Neanderthals systematically drove mammoth herds into the fissure and subsequently butchered the carcasses. La Cotte persists in the literature as a site with clear evidence for socially organised and structured meat-procurement behaviour (Scott, 1980; 1986) and provides an excellent data set for comparison with the faunal remains from Lynford.

This interpretation of La Cotte as a specialised drive-site is based on several lines of evidence. Firstly, Scott (1986) notes that of specific faunal elements, notably scapulae, were stacked at the edge of the site. For example, in layer 6 several mammoth scapulae were stacked to one side of the cave with a rhino skull left on top of the pile. Secondly, the identification of a rib fragment evidently driven into the skull of a single individual - possibly to help in the removal of the brain from the skull. Thirdly, the pattern of surviving bone portions appears consistent, with both denser and weaker regions preserved. There is, however, a noticeable absence of mammoth lower limbs, vertebrae and ribs (Appendix 6 Table 20; Figure 9.14). Whether these skeletal portions were destroyed during burial or removed off-site by either predators/humans is unclear.

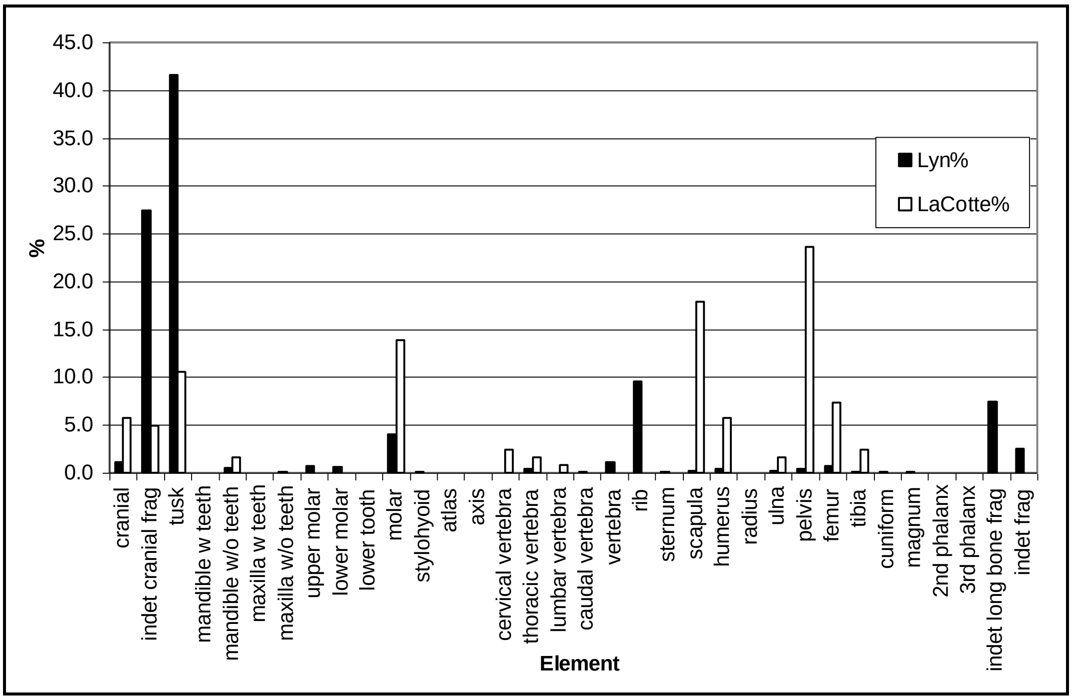

Figure 9.14 Lynford and La Cotte body part representation as a percentage of total NISP

Fourthly, evidence for bone surface modifications on specimens from these layers is limited. Cut-marks were identified on the scapulae and the top and sides of mammoth tusks (Jones and Vincent, 1986). The cut marks identified on mammoth scapulae were along the spine and blade of the elements and relate to meat removal; no cut marks were identified on or around joints, which suggests limited evidence for disarticulation. The location of the cut marks on archaeological tusk specimens were in a similar position to those on modern African elephants; in modern accounts these cut marks were often associated with the removal of meat from the elephant’s head. Finally, the age of mammoth and rhino at La Cotte were calculated and used to suggest that Neanderthals were selecting particular subsets of both populations. The mammoths recovered from layers 3 and 6 were identified as relatively young and prime adult (Scott, 1986). These animals are “least likely to suffer mortality and predation” (Scott, 1986, p182) and “would have been…impossible to kill *en masse* without the use of some kind of trap of pit-fall" (ibid, p183). The author suggests that the fissure at La Cotte would have provided an optimum location for such behaviour.

Having detailed the evidence for Neanderthal hunting-behaviour at La Cotte, this behaviour will be compared with faunal analysis from Lynford; this approach allows for a comparison of human behaviour between these two key Middle Palaeolithic localities. The composition of the faunal population from both sites is indicative of cooler climatic conditions with a predominance of megafaunal species (mammoth, woolly rhino) along with smaller numbers of medium-sized species such as reindeer, horse and bison (see Table 9.21).

Site	**La Cotte**		**Lynford**	
Species	**NISP**	**MNI**	**NISP**	**MNI**
Mammoth	349	*11*	2341	*11*
Rhino	187	*3*	46	*1*
Bos/Bison	11	*1*	4	*1*
Giant deer	2	*1*		
Horse	85	*4*	7	*1*
Red deer	28	*2*		
Reindeer	8	*1*	103	*2*
Grand total	670		2501	

Table 9.21 Comparison of NISP and MNI values for Lynford and La Cotte

Despite the similarity in composition, La Cotte has a lower percentage of mammoth (52.1%) and other megafaunal remains (27.9%) compared to Lynford (93.6%). Both sites have an MNI of 11 for mammoths, calculated through the use of dental pairing and wear sequences; a lower MNI is generated when calculated on post-cranial elements at both La Cotte (layer 3 MNI= 8; layer 6 MNI= 7) and Lynford (MNI = 1-3) (Table 9.21). A comparison of the skeletal element survival and comparison of NISP/MNI values highlights the absence of specific portions from both sites (Appendix 6 Table 20 and Figure 9.14).

At Lynford most mammoth skeletal elements are represented although there is a predominance of cranial, tusk, tooth, vertebra and indeterminate long bone fragments. At La Cotte cranial and tooth fragments are again prevalent along with scapula and pelvic portions; there is an absence of long-bones, especially lower limbs, along with vertebrae, ribs and metapodials. Scott (1986) suggests that this absence reflects the removal of elements off-site, an argument that has similarly been postulated by Schreve (2006) for the low quantities of limb bone at Lynford. As previously discussed, the large quantity of both mammoth indeterminate long bones along with large quantities of large mammal indeterminate long bones at Lynford could represent the *in-situ* destruction of these elements through animal trampling. Difference in dental and post-cranial MNI values provides further evidence of fragmentation throughout the Lynford faunal assemblage.

Fragmentation patterns from layers 3 and 6 at La Cotte reveal bone survival related to specific density; femora and humeri are represented by shaft and distal epiphyses with no evidence for the preservation of the proximal epiphysis. Similarly, scapulae and pelvic portions are dominated by the denser portions such as the acetabulum and glenoid cavity with few specimens preserved from either the ilium or scapula blade (Scott, 1986). Such fragmentation and preservation is in contrast to Lynford. Differences in element representation at both sites could relate to the sedimentary environments, which are more acidic at La Cotte, possibly leading to the leaching and destruction of specimens. It is curious that no dense metapodial or phalageal elements were recovered from La Cotte, although recovery of these elements at Lynford was similarly modest. Evidence for carnivore gnawing of these elements at Lynford could also provide an explanation for their absence at La Cotte. The absence of lower limb elements at La Cotte could have been caused through a combination of acidic sedimentary conditions and element fragmentation. If the mammoth remains were as heavily fragmented as at Lynford, then these smaller portions may have been leached out, causing an underrepresentation of lower limb bones. An alternative explanation could be the transport of these portions off-site by hominins; an absence of faunal material with evidence for disarticulation suggests that meat was removed on-site with little or no intensive butchery.

A small number of specimens from La Cotte (n=5) showed evidence of human bone-surface modifications located on scapulae and on the proximal end of a tusk (Figure 9.15). These signatures suggest that Neanderthals undertook some butchery at the site; the absence of further evidence for human involvement with these carcasses could be a result of the friable and weathered surfaces preventing identification. These human butchery-signatures, though minimal, demonstrate that such modifications can be identified on megafauna (*contra* Haynes, 2002; Schreve, 2006).

Indeed, the evident difference in bone surface quality between these two sites makes the absence of human-modification signatures at Lynford even more apparent.

Figure 9.15 Cut marks on mammoth tusk from La Cotte (from Scott, 1986, Fig 19.4)

No data could be found for quantity and distribution of carnivore modifications at La Cotte, though the absence of proximal longbone portions could represent destruction through carnivore gnawing. A more detailed comparison with Lynford was therefore not possible. It has been suggested that the butchery of megafauna need not leave any cut marks due to the removal of large muscle packages (Haynes, 2002). However, the identification of human butchery signatures on remains from La Cotte and not Lynford could suggest that such modifications were never present at Lynford. The absence of cut marks seems peculiar especially considering the significant evidence for carnivore processing for marrow from longbones and meat from regions such as the pelvis and vertebrae (see Chapter 6).

The age structure of the mammoth population at La Cotte consists of relatively young and prime-aged individuals; this is different to Lynford where prime-aged individuals dominate with fewer juvenile specimens (Lister, *forthcoming*). The pattern at La Cotte is similar to Haynes' Type A profile in which all age classes are represented, though there is an element of selectivity as older individuals are absent

(Haynes, 1991). Haynes has used this structure to argue for the focussed hunting of specific mammoth age-classes by hominin populations. In contrast, the Lynford mammoth age-structure most closely resembles Haynes' Type C profile, which is dominated by prime age animals to the exclusion of juvenile and older individuals (ibid). Such an age structure results from the selective death of individuals over an extended period of time and is more suggestive of a natural mortality structure.

Faunal assemblages from La Cotte and Lynford contain large quantities of megafauna dominated by mammoth remains, though this is where the similarities end. Evidence presented here suggests that formation histories at both sites were completely different. Weathering data indicates a prolonged and continuous input of faunal material at Lynford whilst La Cotte represents a relatively short accumulation history illustrated by the reasonable condition of many bone surfaces. Scott (1986) references several instances of skeletal elements including vertebrae and skulls that not only refit but are in close proximity to each other suggesting material was rapidly covered by loess. Conversely at Lynford faunal material demonstrates evidence for both rapid burial and prolonged exposure (see Chapter 6).

Both sites exhibit a degree of fragmentation though the skeletal representation at Lynford includes a greater number of elements compared to La Cotte. The absence of particular elements and portions form La Cotte could relate to the acidic sedimentary environment resulting in the chemical leaching of smaller fragments. Despite the acidic conditions and poor condition of some bone surfaces, human modification signatures were identified on some specimens from La Cotte. These butchery signatures indicate some degree of meat removal though the absence of comparative data on carnivore modifications does not allow for a more detailed discussion of competition and carcass access. The identification of Neanderthal butchery-signatures on elements from La Cotte, which are generally more friable and poorly preserved, compared to Lynford, supports the conclusion that humans had a limited role in the accumulation of the mammoth fauna at Lynford. The incidence and location of carnivore modifications at Lynford suggests that these groups had primary access to carcass resources.

Faunal material at Lynford and La Cotte accumulated under different depositional environments and arguably illustrate evidence of different Neanderthal meat-procurement behaviours. La Cotte represents the rapid accumulation of faunal material in two horizons with limited weathering and evidence for hominin butchery. Accumulation at Lynford occurred over a longer period of time with no evidence for Neanderthal involvement. Comparison with La Cotte supports the assertion in this thesis that Lynford represents a known locality in the landscape where humans exploited carcass resources, especially marrow. The absence of butchery-signatures identified on remains from La Cotte, and the presence of extensive carnivore modification, suggests a natural death-locality (Haynes Type C) with non-human predators having primary access to carcasses. My analysis has demonstrated that Neanderthals appear to have focussed on marrow from other large-medium sized species at Lynford (see Chapter 6).

La Cotte has been interpreted as a megafaunal drive-site with Neanderthals butchering mammoth and woolly rhino at the base of the fissure (Scott, 1980, 1986). Whilst there is evidence for human involvement and meat removal, there are still unanswered questions regarding the role of carnivores at this site. Weathering and age-structure data suggest a short-term, rapid event in contrast to Lynford; though whether the material accumulated as a direct result of Neanderthal meat procurement behaviour is still a matter for debate. This brief analysis has not disproved the idea of La Cotte as a drive-site, but neither has it found conclusive evidence for it. La Cotte would provide an excellent site for further research using the methodology developed throughout this thesis. In particular it would be interesting to shift the emphasis from mammoth and rhino to the medium-sized species at the site to see whether they demonstrate a similar pattern to the megafauna. A more detailed analysis and discussion of weathering and carnivore modifications is also required to place Neanderthal behaviour firmly within the climatic and depositional environment.

The previous sections have discussed similarities and differences between empirical data from this thesis and sites in the wider European context. Whilst there have been some areas of congruency there are also areas that could be addressed through the application of the methodology developed for this thesis, in order to more clearly understand the interaction and competition between hominins and other predators at some of these sites. The final section of this chapter will discuss the results of my analysis in terms of the evolution of human hunting behaviour and proficiency, and what these results mean in terms of the wider hunting/scavenging debate.

9.3 The evolution of human hunting behaviour

Chapter 2 presented a comprehensive introduction to the ongoing debate surrounding the meat-procurement behaviour of our earliest ancestors. This thesis has contributed toward an understanding of site formation processes and hominin meat-procurement behaviour at key Lower and Middle Palaeolithic localities in northern Europe. The final section of this chapter will focus on the implications of this research for a wider understanding of the evolution of hominin meat procurement behaviour.

Since the antiquity of the human lineage was first identified in the 19th Century, the broadening of the dietary niche to include meat has been viewed as a major driving force in human evolution (Darwin, 1871). Aiello and Wheeler (1995) suggested that a shift to a higher quality diet in Plio-Pleistocene hominins resulted in a reduction in size and hence energetic cost of our ancestor’s gut. Such a reduction, it is argued, allowed for increased encephalization amongst hominin species without placing increased demands on their “overall energy budgets” (Aiello and Wheeler, 1995, p211). This expansion in brain size require an increase in high quality food stuffs such as meat, nuts and underground tubers; it is suggested, therefore, the increased encephalization and emphasis on high quality food required more complex behavioural responses such as stone tools, which led to further selection for larger brains. Hence it could be argued that the development and emergence of the Oldowan in Africa c3mya could represents a technological correlation for increased brain size and the development of more complex behaviour (Aiello and Wheeler, 1995). Whether these groups acquired meat resources through hunting or scavenging behaviour is still open to considerable debate (Binford, 1981; Dominguez-Rodrigo, 2002). Perhaps a good model for the earliest human behaviour can be found through a study of hyaena behaviour, a species that hunts and scavenges and also has a wide vocal communication range capable of transmitting both practical and social information (Kruuk, 1972; Mathevon *et al*, 2010).

Increased encephalization and a shift in dietary focus occurred earlier than the hominin communities studied for this thesis but nonetheless this process has implications for later hominin behaviour. An increase in meat-eating behaviour amongst early hominins would have brought these communities into direct competition with other larger carnivores such as sabre-toothed cats, lions, and hyaenas (Arribas and Palmqvist, 1999). These species were already well adapted to their niche, which would undoubtedly have marginalised early hominins perhaps requiring a focus on scavenging of larger carcasses whilst hunting smaller prey, similar to modern chimpanzees (Arribas and Palmqvist, 1999; Hart and Sussman, 2005). Studies of bone surface modifications from the earliest sites at Olduvai Gorge highlighted a three stage sequence in which hominins appear to have had secondary access after other non-human carnivores (see Selvaggio, 1998a, 1998b, 1998c).

Increased encephalization and the development of stone tools opened up potential ecological niches to early hominins and allowed for movement through different vegetational zones (Arribas and Palmqvist, 1999). An increasing brain capacity would have required more regular access to high-quality food resources, necessitating a further shift in behaviour. The technological correlate for this shift behavioural shift can be observed by the emergence of the Acheulean, which is the first truly global lithic technology and associated with *H. erectus/ ergaster/ heidelbergensis* populations. The anatomy of these fossils suggests an adaptation to open, savannah style grassland with perhaps a capacity for long-distance running (Stringer and Andrews, 2005; Trinkaus *et al*, 1999). These features are used to suggest a hominin with more complex hunting behaviour and there is evidence for the emergence of such behaviour in Africa at sites like Olorgesailie (Isaac, 1978; Pope, 2002).

The evolution of the hominin species and the development of the Acheulean in Africa allowed for a long period of co-existence with other predator and prey species (Arribas and Palmqvist, 1999). This allowed early *Homo* to become established in a niche that allowed for exploitation of meat resources through both hunting and scavenging behaviour. Despite the discovery of numerous sites both across Europe (Atapuerca) and on its boundaries (Dmanisi) there is no clear evidence for active hominin hunting-behaviour prior to c500kya (Arribas and Palmqvist, 1999; Pontzer *et al*, 2010; Turner, 1992;). Turner (1992) suggests that this was due to the composition of the large-carnivore guild that contained species such as sabre-toothed cats and a now-extinct species of hyaena. The wide diversity of large carnivores, he argues, provided too much competition for early hominin colonisers in Europe; in fact it was not until the guild began to represent the modern African-carnivore guild, through the extinction of the larger species, that hominins had the capacity for structured competition and settlement during the early Middle Pleistocene (Turner, 1992). Evidence from sites such as Boxgrove and Schöningen demonstrates that hominins were capable of securing carcasses from large predators such as lions and hyaenas. Such behaviour could not have developed unless hominins had continued to evolve alongside these carnivores across a long time scale. Therefore, perhaps these carnivores became extinct in Europe *because* of the evolution of more efficient hominin hunting strategies resulting in the narrowing of the niches available for these larger predators. Although earlier sites have been identified across Europe and even in Britain (Parfitt *et al*, 2005), none provide more information regarding hominin behaviour than those from the early Middle Pleistocene. At present it appears that by at least 500kya hominin meat-procurement behaviour had become quite sophisticated and these groups were already top predators within many varied environments.

This discussion has demonstrated the potential importance of meat based resources in the evolution and emergence of human ancestors alongside the challenges required to obtain these resources. The focus for this thesis was on sites from the British Middle and Late Pleistocene where evidence suggests that hominin communities were well established and proficient hunters by at least 500kya. This research has demonstrated that at Boxgrove hominin communities were proficient at both hunting and butchery and capable of securing and protecting these carcasses from larger predators and scavengers. In addition, these communities had the capacity to tackle numerous species from varying ecological niches and with different predator-avoidance techniques. The species butchered range from rhino through to smaller species such as roe deer; what does this mean in terms of hominin group size? The data presented for this thesis cannot, at present, provide any information about potential group sizes. Despite extensive evidence for butchery across all species at Boxgrove it is uncertain whether these communities were consuming all the resources from each carcass.

Further work must be done to investigate the yields per animal in order to provide a more accurate estimate of population density.

Further comparisons with the Middle Pleistocene site at Schöningen highlight similarities in butchery behaviour but also perhaps a shift in behaviour towards specialised medium-sized mammal hunting witnessed in the later Middle Pleistocene. It has been tentatively suggested that the lithic and faunal remains from the Q1/B waterhole site at Boxgrove and those from Schöningen could represent the precursor to later Neanderthal hunting techniques. Whilst the evolutionary position of *H.heidelbergensis* in relation to Neanderthals is still being debated (see for example Endicott *et al*, 2009), my analysis has demonstrated that at Boxgrove this species was hunting and butchering in a behaviourally modern way. Such an interpretation is consistent with Voormolen's interpretations of hominin behaviour at Schöningen where "ancient hunters…[were] butchering in a modern fashion" (Voormolen, 2008, p235).

My assessment of Middle Palaeolithic meat-procurement behaviour was limited to an individual site. Lynford does not provide evidence of hunting proficiency but provides further and more detailed information about Neanderthal behaviour. Isotopic studies have compared carbon and nitrogen from Neanderthal remains with other carnivores such as hyaenas (Bocherens *et al,* 2005. The high isotope levels have been interpreted as evidence for the incorporation of a large quantity of terrestrial mammals in their diet). This interpretation places Neanderthals as a top, trophic predator in European open-environments. Such studies are supported by sites such as Biache Saint Vaast, Wallertheim, and La Cotte de St Brelade where researchers have demonstrated evidence for systematic, socially organised meat-procurement behaviour (Burke, 2004; Conard, 1999; Farizy *et al.*, 1994; Gaudzinski, 1995, 1999, 2004; Gaudzinski *et al.*, 2005; Grayson and Delpech, 1994). My analysis of the Lynford fauna demonstrates no evidence for systematic hunting behaviour; instead I have documented evidence for opportunistic subsistence behaviour focussed on marrow processing. Whilst some researchers (Binford, 1981) may dismiss this as further evidence for primitive, scavenging my conclusions demonstrate such behaviour represents a hominin species that was not only well evolved but aware of the resource potential within its environment.

This thesis found no evidence for megafaunal hunting despite the large number of specimens and the presence of lithic tools. Indeed a comparison with La Cotte de St Brelade demonstrates that different site formation processes were responsible at each location and Neanderthals may have had a more important role at La Cotte; nevertheless there is still a need for further work at La Cotte to fully understand the role of humans particularly in relation to other carnivores and throughout the fluctuating climates at the site. This thesis does not reject the idea of systematic hunting by Neanderthals but found no evidence to support it during this analysis.

9.3.1 The hunters or the hunted? The state of the European debate

Chapter 2 documented the ongoing debate regarding early hominin meat-procurement and butchery behaviour. Previous debate, particularly during the 1980s, was polarised between those favouring early hominins as habitual, big-game hunters (Isaac, 1983) and those who perceived all pre-sapiens populations as marginal scavengers (Binford, 1981). Results from this thesis feed directly into this debate. Evidence presented here has not disproved the ‘hunting hypothesis’ but has contributed to the growing weight of evidence against Binford’s habitual-scavenging model.

My analysis of faunal material from the European perspective demonstrates both hominin hunting proficiency and resource awareness. The spread of our ancestors out of Africa was undoubtedly, in part, driven by an increase of meat in their diet along with resources such as marrow. In fact, a focus on meat may have been necessary when colonising northern latitudes, particularly with more pronounced seasons and availability of plant resources (Gamble, 1999). Certainly by 500kya populations of humans in Europe were proficient in the hunting and butchery of a range of both large and medium-sized animals across a range of ecosystems. Even at the earliest sites it is possible to see the emergence of later specialised hunting methods. Later populations of Neanderthals continue to demonstrate a primacy within the carnivore guild and a continuing capacity to hunt and butcher large and medium sized mammals.

This thesis has also highlighted incidences of scavenging behaviour, particularly at Lynford. Whilst this has negative connotations from our modern human perspective, such an approach appears logical considering the climatic and environmental conditions at the site. To a degree our interpretation of past hominin meat-procurement behaviour is structured by the evolutionary framework developed throughout the 19th and 20th Century (Darwin, 1871; Domiguez-Rodrigo, 2002; Lee and Devore, 1968). This idea of progression begins with an age of pre-human behaviour and progresses through scavenging for meat and finally reaching the promised land of habitual, fully-modern hunters. This notion of progress and improvement is not only tied directly into Darwinian notions of ‘survival of the fittest’ but also attempts by modern humans to distance themselves from nature, and other scavenging species such as hyaenas. In part, our interpretation of past human behaviour is reliant on how we, as researchers, view these populations. McNabb (2007) highlights four ways to think about past hominins:

1. more human than animal;
2. more animal than human;
3. a bit of both;
4. a totally unique animal.

Whilst McNabb was utilising this model to discuss the nature of the Clactonian, it is still applicable to the study of hominin meat procurement behaviour. In fact, this list neatly encapsulates the development of thought when discussing the evolution of hominin meat-procurement behaviour (see Chapter 2; Dominguez-Rodrigo, 2002). A sole dependency on a large accumulation of carcass remains would provide considerable uncertainty for hominin groups; a broader and more sustainable approach to meat-procurement would be to hunt first and scavenge as necessary. The analysis of fauna from Lynford provides clear evidence for such pragmatic meat-procurement behaviour. This thesis has demonstrated that, certainly by 500kya, hominin populations were proficient predators with behavioural flexibility to cope with changing climates and environments. Indeed such behavioural elasticity can be traced throughout the Pleistocene cross-cutting a broad spatial context that includes Britain and Europe. In such cases these populations, both *heidelbergensis* and Neanderthals, could be described as totally unique animals.

This thesis has documented a range of meat-procurement behaviours at some of the earliest Palaeolithic localities in Europe. At Boxgrove there is evidence for systematic, anatomical, complex, and even behaviourally modern, butchery. Such behavioural complexity has also been identified from other Pleistocene localities in the wider European context, like Schöningen (see Voormolen, 2008). Analysis of faunal material from each site has produced varying levels of information regarding Pleistocene hominin behaviour. Without detailed excavation, recovery and recording, faunal material from river terrace deposits can only provide generalised information about hominin behaviour within the wider site environment. Sites such as Swanscombe and Hoxne provide tantalising glimpses into meat-procurement during the Pleistocene, but the absence of stratigraphic congruency prevents a more detailed analysis. In contrast, both Boxgrove and Lynford provide a higher level of information on hominin meat-procurement behaviour and interaction with an extinct palaeocommunity.

Chapter 10 Conclusion

Pleistocene sites with deposits that contain modified faunal material and lithic tools demonstrate a hominin presence surrounding these localities. The co-occurrence of such assemblages has been used as evidence for human accumulation related to meat-procurement behaviour (Waechter, 1978). This research project tested this assumption through the analysis of primary faunal data from the key Palaeolithic localities of Boxgrove, Swanscombe, Hoxne and Lynford. This thesis has clearly demonstrated that such an assumption is no longer tenable; lithic/faunal association must be demonstrated, within both a strict spatial and temporal framework. Specific research aims were formulated and rigorously tested throughout this study. These were:

- What taphonomic agents and site formation process are responsible for the accumulation and modification of each faunal assemblage?
- Is there sufficient evidence to discuss hominin subsistence at these study sites?
- Are these subsistence strategies similar to those identified by previous authors

Each of these questions has been addressed and answered through the analysis and discussion of data from each study site. The main conclusions reached in this thesis can be summarised as follows:

1. Faunal accumulation at each site resulted from a combination of natural and cultural formation processes. Each study site demonstrated variation in the role of humans as faunal accumulators. Importantly, this thesis has re-emphasised the need for thorough assessment of all agents of site formation through the use of a systematic and repeatable methodology, such as the one developed for this project.
2. The depositional context at each site determined both the quality and density of recoverable cultural information. In particular, this thesis has highlighted the problems of using faunal material recovered from fluvial horizons at site such as Swanscombe and Hoxne. Frequently at such locations the depth of river-terrace deposits does not allow for lithic and faunal material to be accurately tied to a temporal framework (Bailey, 1983, 2007; Vanquero, 2008). Furthermore high

flow rates identified through sedimentological analysis along with results from a methodical faunal analysis has demonstrated significant assemblage disturbance and fluvial winnowing. Therefore, any humanly-modified faunal material merely represents background human behaviour within the wider river catchment; for more detailed and accurate statements about human meat-procurement behaviour researchers must focus on sites with lower energy depositional environments and where a clear link between lithic and faunal material can be demonstrated. Examples of such sites include Boxgrove and Lynford.

3. Human meat-procurement behaviour was identified at each site through specific bone-surface modification signatures such as cut marks and impact fractures. Nevertheless significant variation was not only identified between these study sites but also with published sites from a wider European context.
    a. Detailed recording and analysis of the position of bone-surface modifications helped to assess both human and non-human carnivore access to carcasses. Boxgrove demonstrated clear evidence for primary access to carcass resources by hominin communities across a wide size and species range; conversely at Lynford, evidence suggests that Neanderthals had secondary access to a narrower range of large-medium sized species.
    b. Not all meat-procurement behaviours were identified at each study location. Such variation may not necessarily represent different strategies but in fact relate to the nature of each study site; for example, whilst Boxgrove has been studied as a single site, it actually represents part of an extinct and buried landscape. Therefore it is perhaps not surprising to identify a wider range of human behaviours at Boxgrove compared to other study sites that provide only a single point on an extinct landscape (e.g. Lynford).
    c. Similarities in human meat-procurement behaviour have been identified through a comparison of the thesis study sites and others from Europe; these included Schoningen, Wallertheim, and La Cotte amongst others. Whilst several areas of congruency have been identified between these sites questions still remain regarding the formation history of some locations and these present further opportunities for research (see below).

10.1 Through the taphonomic lens: Site Formation Agents

In the introduction to this thesis I outlined several site-formation scenarios to act as a referential framework throughout the analysis phase of this research. Each scenario placed a single agent at its centre as solely responsible for faunal accumulation at each study site; these agents included hominins, carnivores, and rivers. This thesis has demonstrated the need to assess all agents of site formation to establish the role of each in assemblage accumulation. More importantly, this thesis has demonstrated how essential it is to fully understand the accumulation history at each site within the context of the depositional environment.

10.1.1 Rivers as agents of faunal accumulation

Fluvial modifications were recorded across each faunal assemblage, though the importance of this agent in bone accumulation and modification varied between sites in relation to differences in the river flow regime. For instance, faunal material from Swanscombe exhibited intensive evidence of hydraulic rounding and fluvial abrasion, and skeletal profiles that demonstrated evidence for fluvial winnowing. Such evidence suggests a powerful river regime that transported and disturbed faunal material throughout a wide catchment area. Whilst other study sites had similar evidence for hydraulic modifications none matched the intensity of the modification at Swanscombe. This thesis has demonstrated the importance of recording and using the faunal long axis orientation to highlight evidence of fluvial disturbance. The importance of this data was demonstrated at each of the remaining study sites. Recent work by Parfitt (2008) on faunal material from the Hoxne excavations not only identified previously unrecognised fluvial deposits but demonstrated faunal long-axis orientation to that flow. Similarly, despite the accumulation of faunal material on floodplain environments at Boxgrove and Lynford, a simple plot of the faunal long-axis demonstrated alignment with slumping events rather than channel flow.

The analysis of faunal material from fluvial deposits at each of the study sites raises important questions about the use and applicability of faunal material and data from such assemblages. This thesis has demonstrated the importance of identifying the intensity of the river flow regime and highlighted at Swanscombe the dramatic influence this had on both faunal accumulation and modification. The intensity of the river flow combined with the depth of the deposits, spanning an entire interglacial (Ashton *et al*, 1996; Schreve, 2004a, 2004b), provides no spatial or temporal correlation between the faunal material and lithic tools at this location. Therefore any human or carnivore bone surface modifications could effectively represent behaviour anywhere within the wider river catchment. This thesis does not support either of the previous interpretations of Swanscombe as a hunting camp (Waechter, 1976) or a marginal-scavenging locality (Binford, 1985). Human behaviour at site such as Swanscombe should be treated as evidence for human 'presence' within the river catchment rather than evidence for sustained meat-procurement and butchery behaviour.

This re-interpretation of human involvement with faunal material fits into more recent investigations of previously excavated sites in particular Ambrona, Torallba and Arridos (Villa, 1995; Villa *et al,* 2005). Throughout the 1970s and 1980s all three localities were similarly interpreted either as evidence for human megafaunal-hunting (Freeman, 1975) or opportunistic scavenging by marginalised hominin-communities (Binford, 1987). Detailed reassessment and taphonomic analysis has provided a fresh interpretation of these sites, highlighting considerable fluvial disturbance at each locality. Humans appear to be of secondary importance at each site, and all interpretations emphasise the absence of sufficient evidence to make detailed determinations regarding subsistence and meat-procurement behaviour (Villa *et al*, 2005). Whilst river localities often provide archaeologists with large quantities of Palaeolithic tools and modified fauna such sites need to be treated cautiously. A detailed assessment of the site formation history and depositional environment is required before human involvement can be assessed. Such sites should no longer be treated as evidence for *in-situ* hominin behaviour but as a 'melting pot' of various taphonomic agents. A more detailed and careful consideration of the fluvial regime at such locales is also required; a greater flow regime most probably represents a wider catchment area, greater transport distances and more intensive disturbance and winnowing. Modified fauna from such deposits should be used cautiously, if at all, to discuss human 'presence' and not as evidence of intensive human behaviour. Deposits that indicate reduced flow rates, for example the Lower Loam (Swanscombe) and the organic, meander-cut off deposits (Lynford), were less disturbed by fluvial processes and hence should be targeted for more detailed information about human behaviour and interaction with the more localised environment.

10.1.2 Seeing the signals but missing the behaviour? Human/Carnivore interaction

One of the most significant conclusions from this thesis is the importance of understanding the depositional context at Palaeolithic sites; this is especially pertinent when considering human behaviour and interaction with their environment and throughout the changing environments of the Pleistocene. Results from each of the study sites have demonstrated distinct differences in the quantity and quality of hominin and carnivore bone surface modifications. Such variation is related both to the depositional environment at each site along with the excavation methodology employed; this has already been demonstrated through a re-interpretation of the importance of humans at Swanscombe and Hoxne. The disturbed faunal assemblage at Swanscombe was not helped by an excavation strategy that focussed on larger, identifiable specimens to the exclusion of both indeterminate fragments and smaller mammals. It is important when re-analysing previously excavated assemblages that researchers are aware of the potential biases introduced through excavation and post-excavation sampling. The behavioural signatures recorded across the bone surfaces at Swanscombe and Hoxne should be viewed as evidence for what Gamble terms ‘patches’ (Gamble, 1999). Without a tight spatial and temporal correlation any link between the modified fauna and lithic material cannot be firmly established (Bailey, 2007). Although we can read the signals and make attempts to interpret them, we can neither establish the behaviour they represent nor the relationship with other animals within the wider environment and across an extended period of time.

In contrast, more recently excavated assemblages from Boxgrove and Lynford have provided detailed evidence of Palaeolithic meat-procurement behaviour by two separate hominin species. The predominance of bone surface modifications at both sites can be attributed to both the depositional environment and excavation methodology. Both sites were systematically excavated and employed a thorough sampling and sieving programme. This ensured that faunal remains of all sizes and dimensions were recovered. In addition, faunal material from both sites was recovered from horizons that illustrated deposition under low-energy conditions. Such conditions allowed the lithic and faunal material to be tied into a strict spatial and temporal framework. This is well supported by evidence of lithic and faunal refits at Boxgrove and results from micromorpholoy, indicating a landscape open for about 100 years; at Lynford, material was excavated from a meander cut-off with little evidence for fluvial disturbance/winnowing and evidence for the slumping of material from the lake margins. Unlike sites from fluvial environments, the study of human behaviour at Boxgrove and Lynford provides evidence for relatively long term, *in-situ* behavioural episodes at each site. Rather than accumulation as a result of other natural agents, the faunal material from these two sites represents evidence for direct accumulation, modification and destruction by hominin communities. Such a high degree of behavioural information, combined with a well defined spatial and temporal correlation, allows for a detailed assessment of human behaviour within the wider site environs.

There is considerable variation in terms of the quantity and distribution of human bone-surface modifications at both Boxgrove and Lynford. Such variation should perhaps not surprising considering that the sites are separated by 440kya and represent behaviour by two separate hominin species. It is arguably unrealistic to expect stagnation in human meat-procurement behaviour across such a long time-scale especially given changes in climate and faunal turnover throughout the Pleistocene in northern Europe (see for example Turner, 1992, Arribas and Palmqvist, 1999). Another reason for the variation in behaviour observed at both sites relates to the scale across which these behaviours were observed. Boxgrove represents part of a preserved land surface that has been traced for over 20km along the West Sussex coastal plain (Roberts and Pope, *n.d*). Boxgrove provides an unparallel view into human behaviour and interaction with other carnivores at a landscape level.

Boxgrove offers a unique insight into Lower Palaeolithic meat-procurement behaviour with overwhelming evidence for active hunting particularly at the horse-butchery site (GTP 17). This single episode of butchery is complemented by supplementary data that indicates evidence for an adaptive procurement strategy focussed on the intercept of animals at a known locale, the Q1/B waterhole. Detailed analysis of bone-surface modifications demonstrates evidence for primary access to a range of carcass sizes from rhino to roe deer. The site provides evidence of holistic butchery by these hominin communities, exploiting all resources including meat, marrow, brain and tongue. Carnivore behavioural signatures frequently overlie human bone-modifications and demonstrate secondary access by these species. The ability to tackle prey species that inhabit different environmental niches and have varying predator avoidance techniques would have required a significant investment in forethought and planning. The hominin communities that inhabited the Boxgrove raised beach 500kya were adept hunters with primary access to most carcasses; evidence presented throughout this thesis demonstrates that these communities were holistically butchering these carcasses whilst keeping scavengers and large carnivores, such as lions and hyaenas, at bay. My analysis supports previous interpretations of this site and assemblage (Roberts and Parfitt, 1999).

Analysis of the Lynford fauna highlights a more opportunistic hominin carcass-processing behaviour. Unlike Boxgrove, where extensive cut marks and other bone modification signatures were identified, none were found on fauna from Lynford despite the presence of large quantities of stone tools in the same deposits. All hominin modification was related to marrow processing from the long bones and mandible, the latter causing fractured cheek teeth that were also identified across species at Boxgrove and Hoxne as well as other Palaeolithic sites from Europe (Conard, 1999; Farizy *et al.*, 1994; Gaudzinski, 1992; Grayson and Delpech, 1994; Tuffreau and Somme, 1988). No hominin modification could be located across the mammoth remains, despite the dominance of this species in the faunal assemblage. This is in contrast to Boxgrove where megafaunal species, particularly rhino, were intensively and extensively cut marked. Faunal analysis demonstrated a predominance of carnivore modification across the mammoth fauna associated with both the removal of meat from regions such as the pelvis and spinal column and marrow-processing from long bones. An absence of hominin modification probably indicates that scavengers had already removed the majority of the carcass products.

None of the modifications on fauna at Lynford demonstrate clear evidence for direct accumulation as a result of hominin meat-procurement behaviour; indeed, natural modification, particularly weathering data, and mammoth age and sex data indicate the attritional accumulation of material at this location through the natural death of these animals. The absence of evidence for hominin primary access and butchery suggests that faunal remains at Lynford accumulated as a result of natural deaths that were subsequently exploited by carnivores and hominins. This behaviour, though different from the pro-active behaviour witnessed at Boxgrove, should not be viewed as more primitive. The detailed climatic and palaeoenvironmental data from Lynford indicate a cold grassland with temperatures ranging from -10 to 15°C. The Lynford waterhole would have provided a focal point in this largely treeless landscape as demonstrated by the accumulation of faunal, lithic and faecal material around the lake margins (see also Voormolen, 2008, Gaudzinski, 1996). The variation in temperatures would have provided optimal conditions for the preservation of carcass resources allowing for future exploitation during the warmer summer months (Coope, *in press*). Hominin modifications across other species such as reindeer and horse indicate secondary access to carcasses and a shift in emphasis to marrow processing of long bones and mandibles. Such a focus on high value fatty products would have provided greater energy sources and perhaps relates to the colder climates inhabited by these individuals. Lynford represents a single point on an extinct landscape but demonstrates that Neanderthals were aware of the wider resource landscape and this site may represent one stop off point in a wider Neanderthal territory (White, 2006; White *et al*, 2006). My analysis of the Lynford fauna does not support the idea of primary faunal accumulation through Neanderthal hunting (Schreve, 2006). This does not mean that these communities could not hunt, just that this thesis has found no evidence for it at Lynford.

10.2 Hunting and Scavenging- the state of the European debate

The nature of the human lineage and their modernity has often been judged by their perceived subsistence strategy (see for example Dart, 1959; Darwin, 1871; Dominguez-Rodrigo, 2002; Lee and Devore, 1968). Such an approach is down to the link made by Darwin between bipedalism, tool production and carcass processing (Darwin, 1871). The use of an evolutionary framework has formed the basis by which our human ancestors are judged and is more popularly referred to as the "Hunting and Scavenging" debate (Hart and Susman, 1999, p23). Since the 19th Century several competing hypotheses regarding meat-procurement behaviour have been developed including:

1. hominins as habitual hunters
2. hominins as scavengers
3. a mixture of both

Frequently this debate has been framed within the African context particularly at some of the earliest sites in Olduvai Gorge and South Africa where the earliest stone tools have been recovered. These lithics are viewed as a technological correlate of increasing brain size, which according to recent studies would have necessitated a shift to higher-energy foods, including meat, amongst our Plio-Pleistocene ancestors (Aiello and Wheeler, 1995). The results from this thesis have demonstrated that meat procurement behaviour throughout the British Pleistocene was flexible, dynamic and linked to local climatic and environmental shifts. This thesis casts doubt on the applicability of the hunting/scavenging framework to Pleistocene northern Europe.

Both Boxgrove and Lynford demonstrate different behavioural signatures and procurement approaches; neither behaviour is seen as more or less successful but both represent excellent adaptations to the environmental and climatic conditions. Similarly, Schöningen provides clear evidence that Lower Palaeolithic *heidelbergensis* populations were skilled and adept hunters, in a behaviourally modern way (Voormolen, 2008). In comparison with results from Boxgrove analysis we can begin to see the emergence of later specialised hunting behaviours (Gaudzinski, 1996). The behavioural evidence presented throughout this thesis supports current theories regarding the evolutionary position of *H. heidelbergensis* as a precursor to later Neanderthal populations (Endicott *et al*, 2009).

During the Middle Palaeolithic human populations were also skilled hunters as demonstrated from isotope analysis and the prevalence of single-species kill sites (Gaudzinski, 1995; Valensi and Psathi, 2005). Whilst this thesis only studied a single Middle Palaeolithic locality, Lynford, the results highlight a meat-procurement behaviour that is different to any previously detailed within the literature. A comparison with the mammoth site at La Cotte demonstrates considerable differences in faunal preservation, mammoth age/sex structure and bone surface modification (Scott, 1980). There was no common, comparative ground to suggest that both sites represent megafaunal kill-sites; in fact the emphasis on marrow processing at Lynford suggests that this site represented a known, possibly annual, stop-off point.

This thesis casts significant doubt on the continued use of the hunting/scavenging binary in discussions of meat procurement behaviour throughout the Pleistocene. Even at the earliest identified sites in Europe there is clear evidence for hominin hunting and primary access to carcass resources (Roberts and Parfitt, 1999; Voormolen, 2008). Whilst there is evidence for marrow processing this thesis strongly rejects Binford's notion of these populations as marginal scavengers (Binford, 1985). Indeed, this thesis has demonstrated that different meat-procurement behaviours need not represent different ends of a spectrum but a continuum of behaviour; indeed the example of Boxgrove highlights several different behaviours across a palaeolandscape. Such opportunities to view hominin behaviour and interaction over such a wide area are rare and it is no surprise, therefore, that we do not always find all behaviours represented at a single locality; where only a single viewpoint into past life-ways is available we may well be seeing the signals but missing the behaviour. This thesis strongly argues for a consideration of all meat-procurement behaviour detailed at sites across north-west Europe to be considered as a representation of this spectrum. Hominin communities in northern Europe throughout the Lower and Middle Palaeolithic certainly appear to be hunting and butchering in a very modern way. It is time to move beyond the simplistic hunting or scavenging debate and attempt to get at the individuals involved and their relationships with the wider palaeoenvironment (Gamble and Porr, 2005).

10.3 Future Research

There is still work to be undertaken to fully understand the role of hominins as accumulators and modifiers of faunal material. My findings point to a number of areas where future research could be usefully directed.

Firstly, only four sites were assessed in this research project and these were restricted to the British Isles. It would be extremely interesting to expand the scope of this preliminary study to include sites from continental Europe to provide a broader understanding of hominin behaviour in the wider European context. Particularly, how this equates to Britain's shifting position between peninsula and island throughout the Pleistocene (Ashton and Lewis, 2002; Preece, 1995; White and Schreve, 2000). It is also important to continue work at the site of Boxgrove, as this site provides clear unambiguous evidence for hominin meat-processing behaviour, and allows this to be assessed both at a site-specific and landscape scale. Such an opportunity is very rare for the Lower Palaeolithic and should be utilised more fully.

Secondly, incorporating a greater number of sites that span a larger time-frame and geographical region would allow for an assessment of changing behaviour particularly in relation to the emergence of specialised hunting behaviour in the early Middle Palaeolithic and the later Middle Palaeolithic exploitation of smaller game. It would be interesting to see whether the behaviour patterns highlighted for the late Middle Palaeolithic site of Lynford are comparable to patterns observed on the continent at sites like Lehringen (Germany) and La Cotte de St Brelade (Jersey).

Thirdly, the methodology developed and used throughout this study has only been tested on open air localities and it is necessary to test the framework using faunal assemblages from cave localities. This may necessitate the modification of the database to incorporate taphonomic agents that are unique to cave sites and not already in the database. In addition, analysing cave locales and comparing these with open air sites would help to provide a more holistic understanding of hominin subsistence behaviour within and across numerous environments.

Fourthly, this analysis has focussed on animal resources and the physical evidence for hominin exploitation at numerous points throughout the Pleistocene. The role of plant resources by early hominins has been widely documented (see Chapter 2) and future projects could benefit from considering the role such resources may have played throughout the Pleistocene.

Fifthly, further research into animal behavioural ecology, for both predator and prey species, would help understand interaction and competition during the Palaeolithic. Although some animal behavioural ecology was used in this study, additional research is required in order to explain and model how hominin communities were able to adapt their subsistence strategies to incorporate species with different social structures, habitat preferences and degrees of ferocity.

Finally, this study has demonstrated the need for continued and more detailed work on taphonomic agents unique to northern Europe, particularly in relation to weathering and the role of rivers in faunal accumulation and site formation. Many of the schemes and research frameworks used by zooarchaeologists working in Europe have been developed in modern African savannahs, which have a climate vastly different to Pleistocene Europe. It is important to address this issue through experimental observation in order to have referential frameworks relevant to the geographical area under investigation.

10.4 Concluding remarks

An explicit methodological approach is essential for demonstrating a link between stone tools and faunal remains from the same deposit (see Vaquero, 2008). The occurrence of both indicates a hominin presence at a site, though this does not necessarily indicate a direct association between the two. A detailed understanding of past hominin behaviour requires identification and analysis of all other potential sources of faunal assemblage accumulation and disturbance; most importantly, any discussion of meat-procurement behaviour requires a discrete spatial and temporal framework. Sites with low-energy depositional conditions provide the most suitable locations for the recovery of large quantities of well provenance faunal material; high-energy river environments can provide large collections of faunal material, but these often represent accumulation across a long time range and are frequently skewed by fluvial processes. My results feed into the growing corpus of European literature that challenges previous interpretations of site formation and more explicitly that hominins played a central role in faunal accumulation (Ashton *et al.*, 2008; Stopp, 1993, 1997; Vaquero, 2008; Villa, 1990; Villa *et al.*, 2005).

This research supports, and builds upon, ongoing research into hominin meat-procurement behaviour at sites in Europe and Africa (Dominguez-Rodrigo, 2002; Voormolen, 2008). A strict division of human meat-procurement behaviour into either hunting or scavenging can no longer adequately explain the evidence from the archaeological record. This thesis has demonstrated considerable variation and flexibility in meat-procurement behaviour throughout the Pleistocene. The systematic and intensive butchery across a range of species at Boxgrove, and mirrored at other Lower Palaeolithic sites, demonstrates a behaviourally modern approach to carcass processing. Alongside such clear evidence for primary access and active butchery, this research highlights evidence for the opportunistic exploitation of naturally occurring carcasses (Lynford). Previous interpretations of similar sites may only have focussed on the evidence for passive human scavenging behaviour (see Binford, 1985); this project contests the notion that scavenging represent cultural primitiveness and suggests instead that hominin communities had a greater awareness of available resources within their wider palaeoenvironment.

The archaeological record of hunting and butchery, given its durability and widespread distribution, offers a rich seam for discerning both the emergence of modernity and distinctive behaviour patterns characteristic of other human species. We are arriving firmly at a position where the mystique surrounding Lower and Middle Palaeolithic meat-procurement behaviour is gradually being dispelled. There is abundant evidence to suggest that *Homo* had emerged as top predators by at least 500kya (Roberts and Parfitt, 1999; Voormolen, 2008). There is also emerging a greater consensus that the behavioural context in which meat procurement took place was complex in terms of both individual agency and group dynamics from its earliest origins (see Dominguez-Rodrigo, 2002; Gamble and Porr, 2005). This more sophisticated approach has allowed us to move beyond polarised debates between primitiveness and modernity, hunting and scavenging, to a more realistic understanding of these behaviours as extensions of social and demographic processes rather than merely trophic interactions between predators and prey. Through the continued marriage of scientific approaches to the taphonomy of butchery signatures and a wider appreciation of social and cognitive context, we will continue to move beyond merely describing the mechanics of butchery processes and bring ever more sharply into focus the complex dynamic between hominin society, their prey and their landscape.

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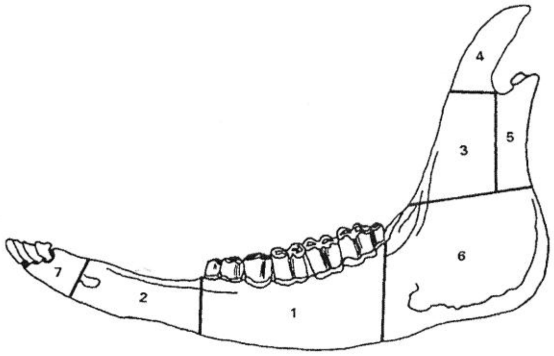
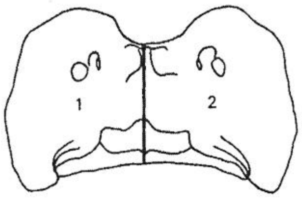
Appendix 1 – Element diagnostic zones

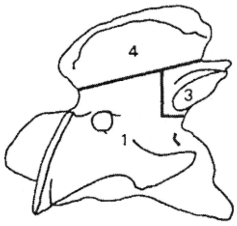
Mandible diagnostic zones

	Zone	Description
	1	Tooth row
	2	Diastema including mental foramen
	3	Coronoid process
	4	Anterior portion of ascending ramus
	5	Condyle and neck
	6	Ascending ramus
	7	Corpus manibulae

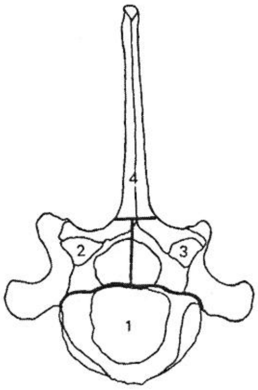
Atlas diagnostic zones

	Zone	Description
	1	Left half of element
	2	Right half of element

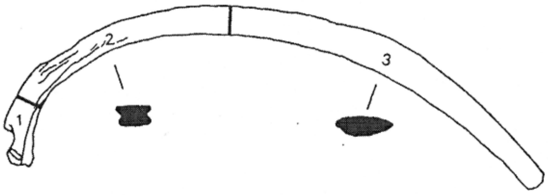
Axis diagnostic zones

	Zone	Description
	1	Head and body
	2	Right articular and transverse process
	3	Left articular and transverse process
	4	Spinous process

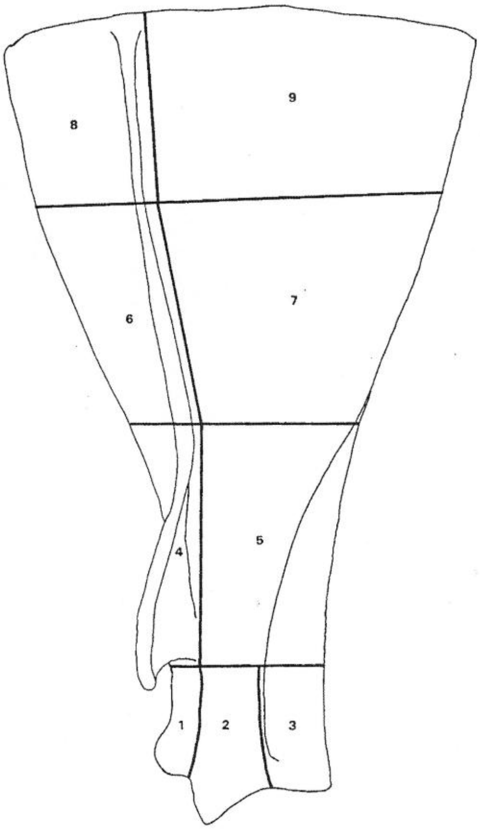
Vertebrae diagnostic zones

	Zone	Description
	1	Head and body
	2	Right articular and transverse process
	3	Left articular and transverse process
	4	Spinous process

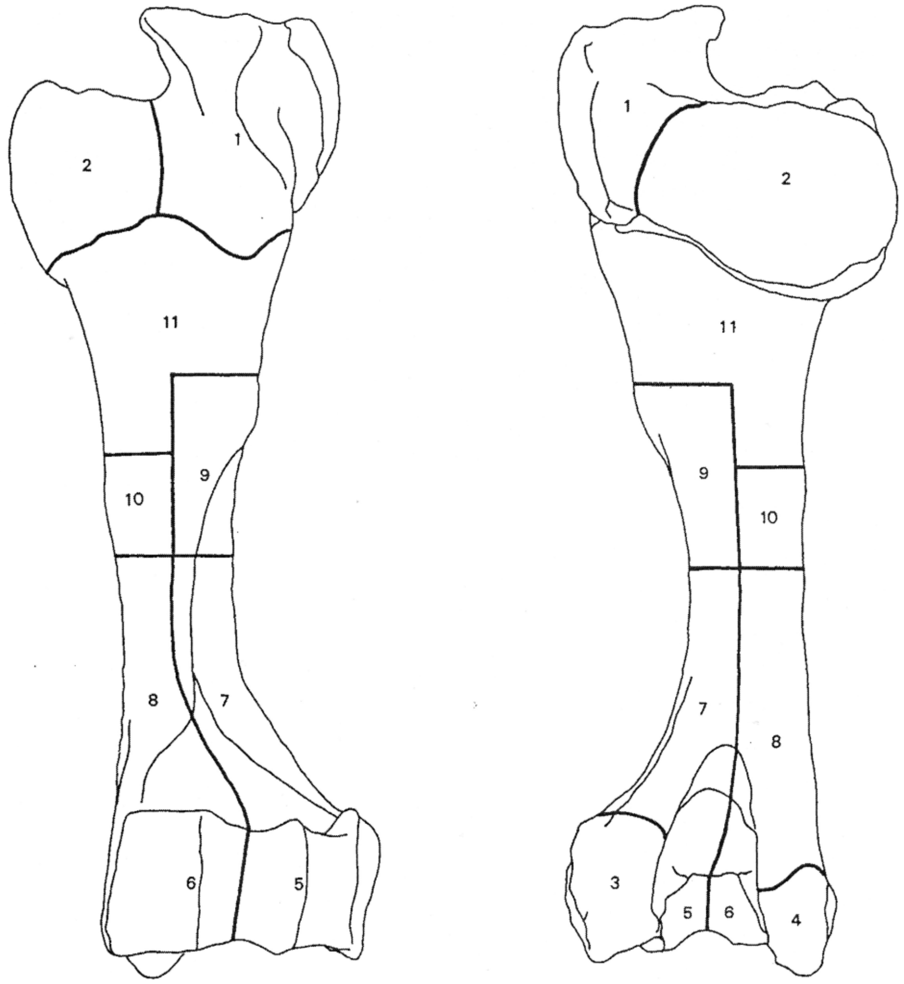
Rib diagnostic zones

	Zone	Description
	1	Head, neck and tubercle
	2	Portion of shaft with square section
	3	Portion of shaft with flattened section

Scapula diagnostic zones

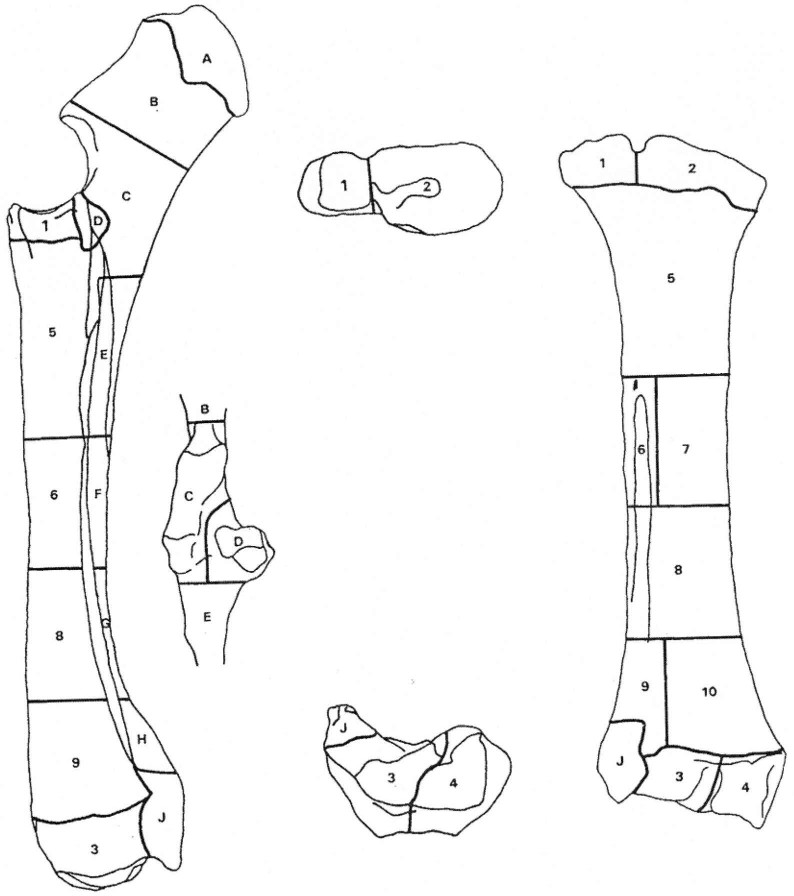
	Zone	Description
	1	Tuber scapulae
	2	Anterior half of glenoid cavity
	3	Posterior half of glenoid cavity
	4	Portion of blade including acromion and tuber spine
	5	Portion of blade including nutrient foramen
	6	Mid portion of blade including spine and supraspinous fossa
	7	Mid portion of blade including infraspinous fossa
	8	Portion of blade including spine and anterior angle
	9	Portion of blade including posterior angle

Humerus diagnostic zones



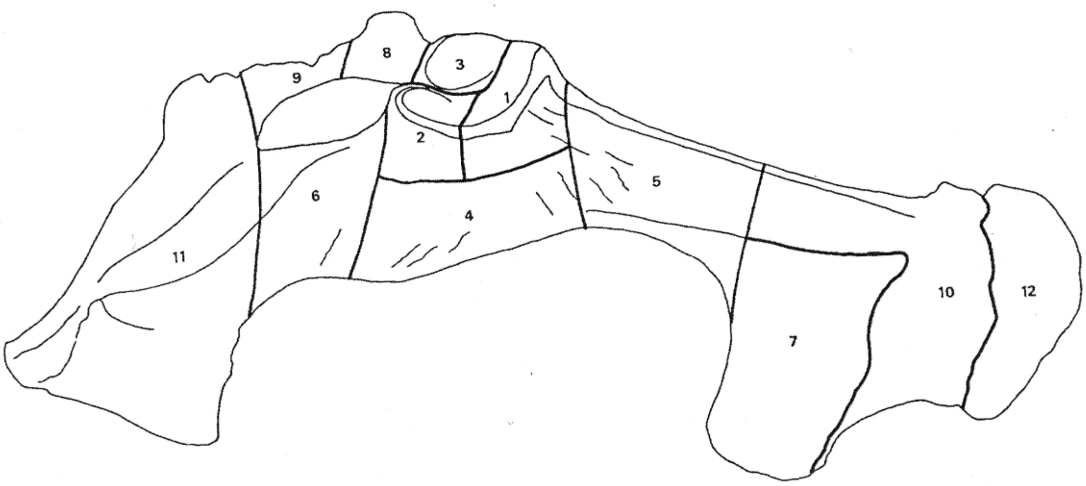
Zone	Description
1	Lateral tuberosity
2	Head including medial tuberosity
3	Lateral epicondyle
4	Medial epicondyle
5	Lateral condyle
6	Medial condyle
7	Lateral distal half of shaft
8	Medial distal half of shaft including nutrient foramen
9	Deltoid tuberosity
10	Tuberculum teres
11	Proximal portion of shaft

Radius and ulna diagnostic zones



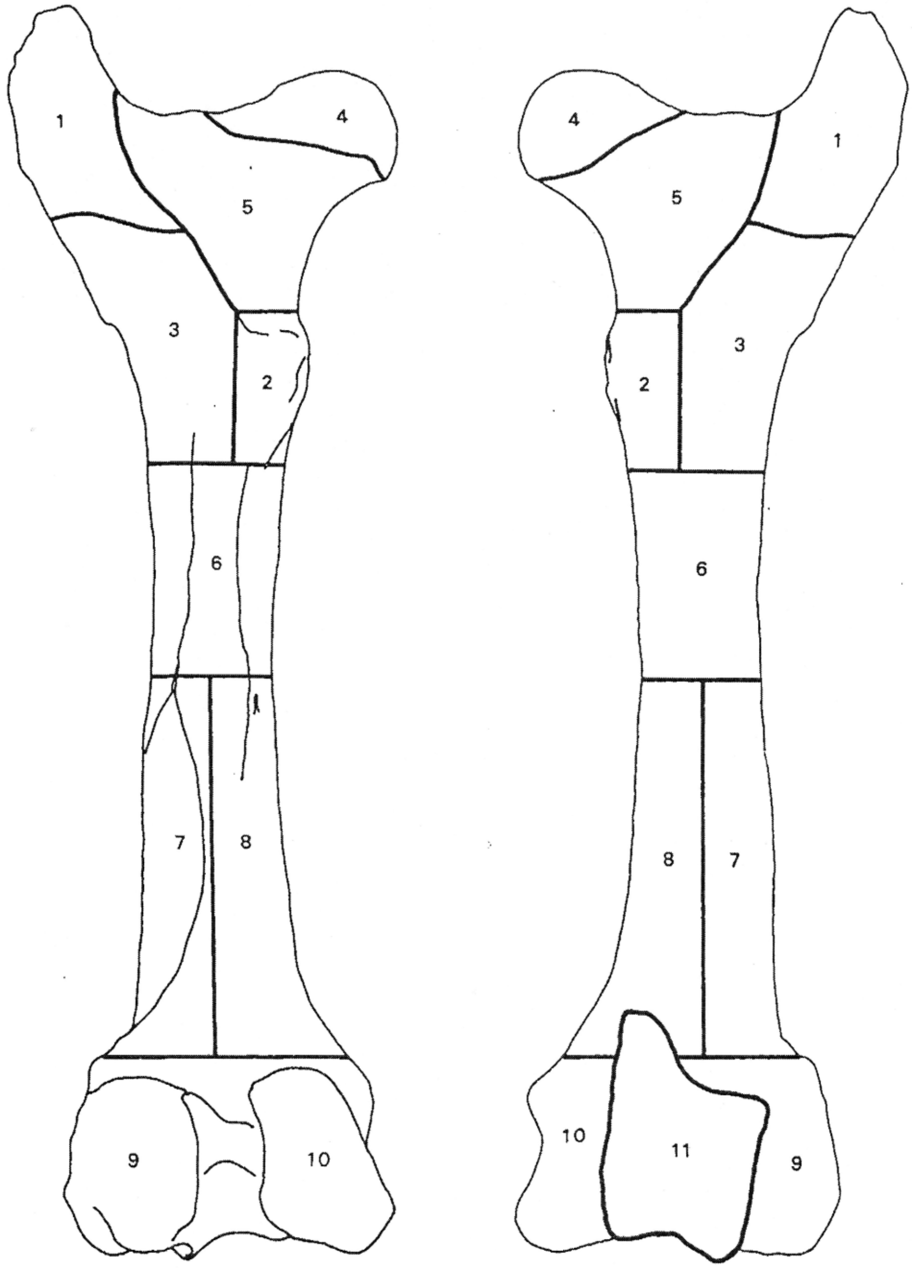
Zone	Description
1	Lateral portion of humeral articular surface including coronoid process and radial tuberosity
2	Medial portion of humeral articular surface including glenoid cavity and radial tuberosity
3	Lateral portion of distal articulation
4	Medial portion of distal articulation
5	Proximal portion of shaft including proximal inter-osseous space
6	Lateral portion of shaft including proximal portion of ulna scar below nutrient foramen
7	Medial portion of shaft
8	Shaft including remaining ulna scar
9	Distal shaft incorporating distal inter-osseous space
10	Medial portion of distal shaft
A	Olecranon
B	Portion of ulna between the olecranon and Processus anconaeus
C	Processus anconaeus, semilunar notch and posterior portion
D	Lateral articular surface
E	Portion of shaft inferior to articular surface
F	Mid portion of shaft
G	Distal portions of shaft
H	
J	Styloid process

Pelvis diagnostic zones



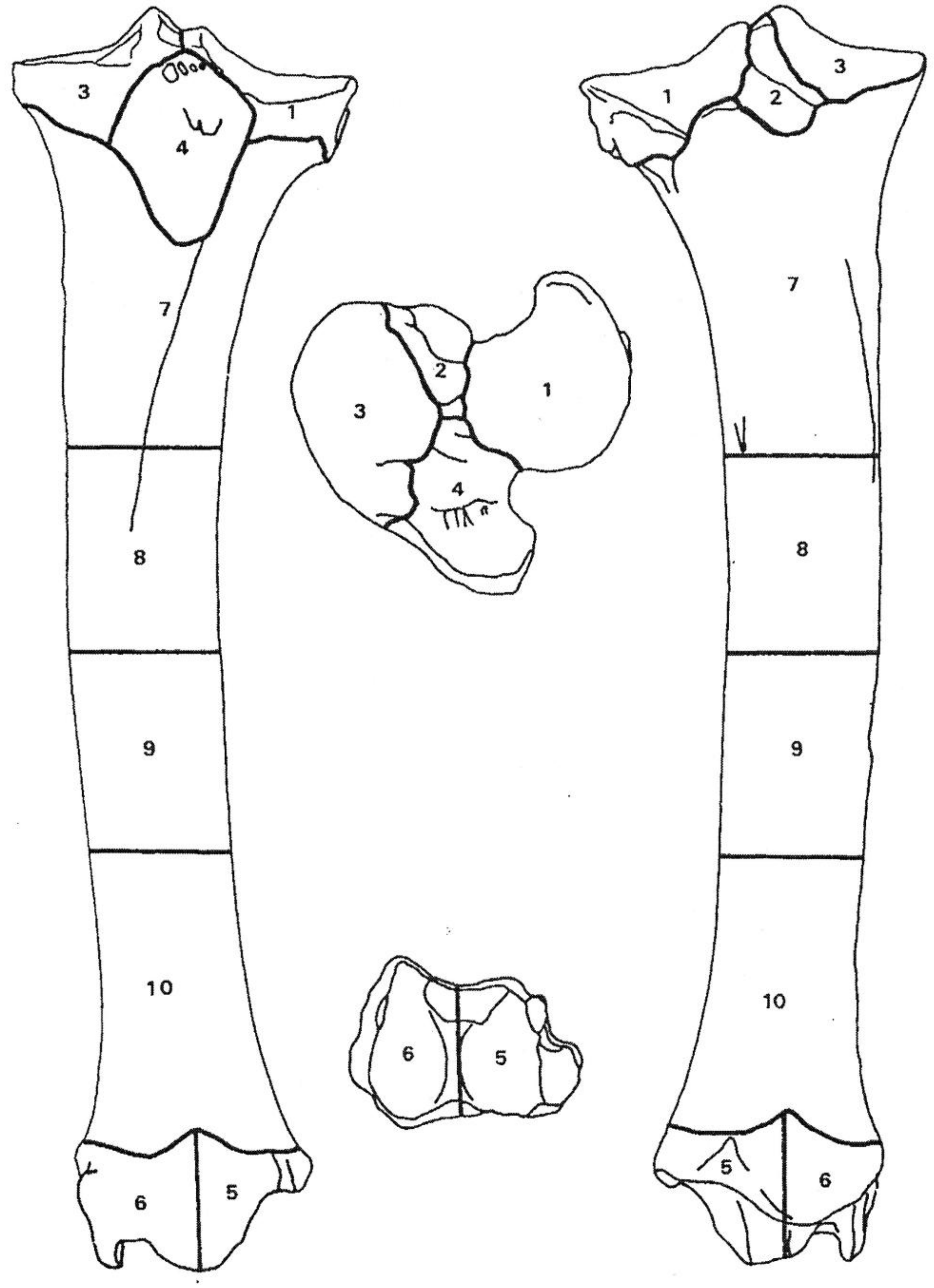
Zone	Description
1	Cranial portion of acetabular articulation
2	Acetabular articulation divided by acetabular fossa
3	
4	Ischial spine
5	Shaft of ilium including greater sciatic notch
6	Portion of ischium opposite obturator foramen
7	Portion of ilium which articulates with sacral wing
8	Portion of pubis including ilio-pectineal eminence and pubic tubercule
9	Remaining portion of pubis including acetabular and symphysial branch
10	Remaining portion of ilium
11	Remaining portion of ischium
12	Tuber coxae

Femur diagnostic zones



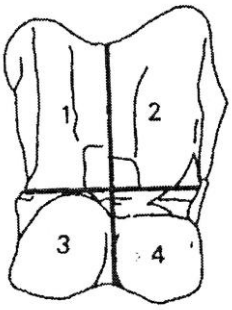
Zone	Description
1	Trochanter major
2	Trochanter minor
3	Trochanter tertius (only perissodactyles)
4	Head
5	Trochanteric fossa and neck
6	Mid portion of shaft
7	Lateral portion of shaft including nutrient foramen and vascular groove
8	Medial portion of shaft including supracondular crest and supracondylar fossa
9	Medial condyle and epicondyle
10	Lateral condyle and epicondyle
11	trochlea

Tibia diagnostic zones

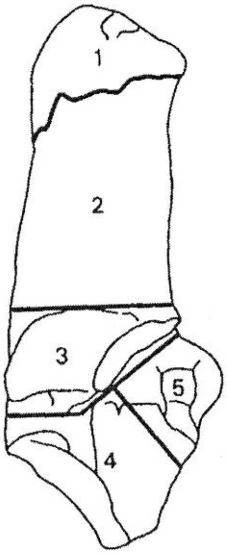


Zone	Description
1	Medial condyle
2	Intercondylar fossa
3	Lateral condyle
4	Proximal tuberosity
5	Medial malleolus
6	Lateral malleolus
7	Proximal portion of shaft
8	Mid portions of shaft
9	
10	Distal portion of shaft

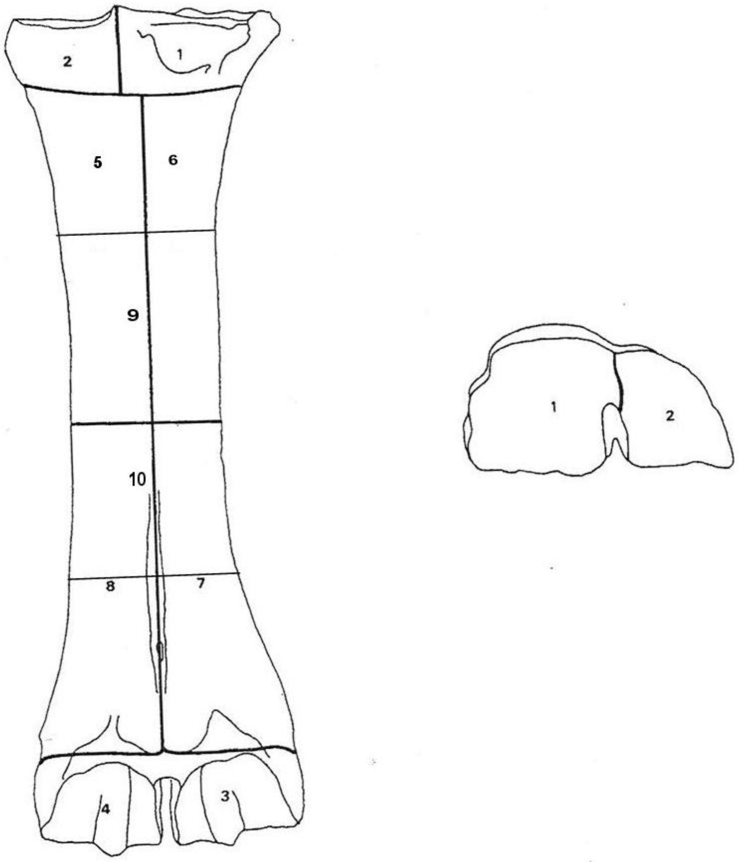
Astragalus diagnostic zones

	Zone	Description
	1	Medial half of trochlea
	2	Lateral half of trochlea
	3	Medial half of distal articulation
	4	Lateral half of distal articulation

Calcaneum diagnostic zones

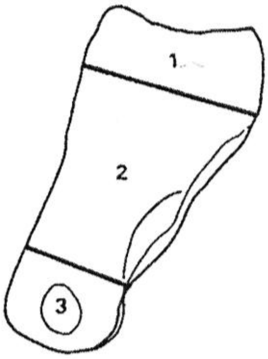
	Zone	Description
	1	Tuber calcis
	2	Body
	3	Sustentaculum
	4	Distal tuberosity and articulation
	5	Processus cochlearis

Metapodial diagnostic zones

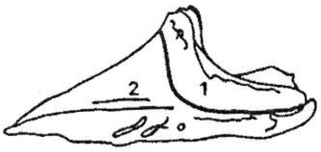


Zone	Description
1	Lateral portion of proximal articulation
2	Medial portion of proximal articulation
3	Lateral condyle
4	Medial condyle
5	Proximal half of shaft
6	
7	Distal half of shaft
8	
9	Proximal midshaft
10	Distal midshaft

1st and 2nd phalanx diagnostic zones

	Zone	Description
	1	Proximal articulation
	2	Distal articulation
	3	Shaft region

3rd Phalanx diagnostic zones

	Zone	Description
	1	Proximal articulation
	2	Distal portion of bone

Appendix 2 – Boxgrove results and analysis tables

Table 1 NISP counts for each species

Species	NISP
Elephant sp.indet	1
Stephanorhinus hundshemensis	39
Bison priscus	8
Bovidae sp. indet	11
Megaloceros verticornis	8
Equus ferus	145
Cervus elaphus	121
Dama dama	15
Capreolus capreolus	121
Cervidae sp. inder	358
Large mammal	365
Cattle/horse sized	3
Deer/horse sized	1
Deer sized	133
Indet	323
Total	**1652**

Table 2 NISP counts for major contexts

Context	NISP
unit 2	
unit 3	4
unit 3/4	6
unit 3c	299
unit 3x	1
unit 4	92
unit 4a	2
unit 4b	112
unit 4b (2l)	252
unit 4c	367
Unit 4c/5a	12
unit gc	13
gully fill	12
unit 4d	22
unit 4e	3
unit 4u	84
unit 5	4
unit 5a	191
unit lgc	2
unit 5b	16
unit 5b/6	1
unit 5c	13
unit 6	44
unit 7	1
unit 8	10
unit 11	28
Total	**1591**

Table 3 Indeterminate or ambiguous contexts

Context	NISP
216 junction	1
3150-2580	1
G	3
Indet	13
redeposited sand	9
SP 5	1
spit 1	1
spit 3	1
SPIT 4	1
SPIT 6	1
SPIT 8	2
spoil	1
unit 16 and 12	1
UNIT 18	2
unit 24	1
unit 25	1
unit b	1
unit fe	2
UNIT G	1
UNIT GF	7
unstratified	8
(blank)	2
Total	**61**

Table 4 General weathering using NISP counts

Weathering Code	NISP
0	455
1	601
2	414
3	144
4	38
Total	**1652**

Table 5 Weathering of faunal assemblage by major context using NISP values

	Weathering Code					
Context	**0**	**1**	**2**	**3**	**4**	**Total**
unit 2						
unit 3	2	1	1			4
unit 3/4		3	2	1		6
unit 3c	22	94	47	23	4	190
unit 3x				1		1
unit 4	24	30	19	16	3	92
unit 4a		1	1			2
unit 4b	28	40	38	5	1	112
unit 4b (2l)	47	99	84	19	3	252
unit 4c	127	141	69	25	5	367
unit gc	8	1	4			13
gully fill		1	11			12
unit 4d	6	13	2	1		22
unit 4e	2	1				3
unit 4.3c	31	43	27	7		108

(Table 5 continued)

unit 4.4u	7	6	3	3		19
unit 4u	16	20	17	7	5	65
unit 4u/4.3c	1					1
unit 5		3	1			4
unit 5a	96	32	35	20	8	191
unit lgc	2					2
unit 5a/4c			12			12
unit 5b	2	3	9		2	16
unit 5b/6			1			1
unit 5c	4	7	1	1		13
unit 6	13	17	7	6	1	44
unit 7			1			1
unit 8	1	1	3	5		10
unit 11	3	20	4	1		28
Total	**442**	**577**	**399**	**141**	**32**	**1591**

Table 6 Weathering of assemblage by species using NISP counts

	Weathering Code					
Species	**0**	**1**	**2**	**3**	**4**	**Total**
Elephant sp. indet			1			**1**
Stephanorhinus hundsheimensis	6	14	15	2	2	**39**
Bison priscus		1	4	3		**8**
Bovidae sp indet	1	5	2	3		**11**
Megaloceros verticornis	4	3	1			**8**
Equus ferus	27	49	57	9	3	**145**
Cervus elaphus	31	41	28	17	4	**121**
Dama dama	14	1				**15**
Capreolus capreolus	56	42	21	1	1	**121**
Cervidae sp indet	143	115	73	15	12	**358**
Large mammal	75	141	91	47	11	**365**
Cattle/Horse Sized	1		2			**3**
Deer/Horse size			1			**1**
Deer sized	19	54	42	15	3	**133**
Indet	78	135	76	32	2	**323**
Total	**455**	**601**	**414**	**144**	**38**	**1652**

Table 7 Natural modification and distribution across species

Species	**Abrasion**	**Cracking**	**Hydraulic Action**	**Pitting**	**Scratch Marks**
Elephant sp. indet	0	1	0	1	1
Stephanorhinus hundsheimensis	0	21	0	21	3
Bison priscus	0	4	0	4	0
Bovidae sp indet	0	12	1	12	6
Megaloceros verticornis	0	4	0	5	0
Equus ferus	13	92	1	60	2
Cervus elaphus	3	47	1	54	5
Dama dama	0	1	1	6	0
Capreolus capreolus	0	36	0	36	4
Cervidae sp indet	1	142	5	134	15
Cattle/Horse Sized	0	3	0	2	1
Deer sized	0	78	2	64	16

(Table 7 continued)

Large mammal	1	194	18	170	37
Indet	0	193	0	154	28
	18	828	29	723	118

Table 8 Distribution of cervids throughout major Boxgrove contexts

Context	Megaloceros vertivornis	Cervus elaphus	Dama dama	Capreolus capreolus	Cervidae sp indet	Total
unit 2						
unit 3		1			1	**2**
unit 3/4						
unit 3c		19		2	37	**58**
unit 3x						
unit 4		3		6	10	**19**
unit 4a				1		**1**
unit 4b	3	3		15	27	**48**
unit 4b (2l)	3			1	21	**25**
unit 4c		57	4	70	80	**211**
unit gc		2		3	7	**12**
gully fill	1				10	**11**
unit 4d		10			6	**16**
unit 4e				3		**3**
unit 4.3c		1	1	1	34	**37**
unit 4.4u				1	3	**4**
unit 4u					4	**4**
unit 4u/4.3c						
unit 5						
unit 5a	1	20	9	12	85	**127**
unit lgc				2		**2**
unit 5a/4c					2	**2**
unit 5b					3	**3**
unit 5b/6		1				**1**
unit 5c					4	**4**
unit 6		3	1		4	**8**
unit 7		1				**1**
unit 8						
unit 11					2	**2**
Total	**8**	**121**	**15**	**117**	**340**	**601**

Table 9 Combined red deer and cervid sp. indet NISP, MNE and MNI values

Element	NISP	MNE	MNI
antler/horncore	72		
cranial	11		
mandible w teeth	3		
mandible w/o teeth	16	8	3
maxilla w teeth			
maxilla w/o teeth	17	1	1
deciduous incisor			
decidous premolar	5	1	1
canine	1	1	1
incisor	5	5	2
premolar	5		
molar	77	10	5

(Table 9 continued)

upper teeth	2	2	1
lower teeth	4	4	1
tooth	31		
atlas	3	1	1
axis	1	1	1
cervical vertebra	5		
thoracic vertebra	8		
lumbar vertebra	5		
sacral vertebra	2		
caudal vertebra			
vertebra	3		
rib	8		
scapula	30	7	4
humerus	10	3	2
radius	11	2	2
ulna	1	1	1
radius+ulna	3	1	1
metacarpal	14	2	2
pelvis	5	3	2
femur	13	2	2
patella	1	1	1
tibia	22	3	2
metatarsal	32	5	3
metapodial	14	1	1
astraglaus	2	2	2
calcaneum	2	2	1
malleolus	3	3	2
uniciform	1	1	1
lunate	2	2	2
cunifrom	2	1	1
navicular	3	2	2
sesamoid	1	1	1
carpal			
tarsal	1	1	1
magno-trapezoid	1		
scaphoid	1		
1st phalanx	1	1	1
2nd phalanx	5	3	2
3rd phalanx	1	1	1
indet cranial frag	9		
indet tooth frag	2		
indet humerus			
indet long bone frag	1		
indet frag	4		

Table 10 Red deer (including sp. indet) preservation of mandibular element portions

Element	NISP	Comp	Tooth row	Diastema	Coronoid process	Anterior ascending ramus	Condyle	Ascending ramus	Corpus mandivuale	indet
Mandible	15	1	3	4	2	1	3	3	2	9

Table 11 Red deer (including sp. indet) preservation of vertebral element portions

Element	NISP	Comp	Zone 1	Zone 2	Zone 3	Zone 4	Indet
Atlas	3	0	2	2			1
Axis	1	0		1			
Cervical	3	0	2	3	2	2	
Thoracic	3	0	1	2	2	3	
Lumbar	4	0	3	2	3	1	
Sacral	3	0	1				2
Vertebra	3	0	3				

Table 12 Red deer (including sp. indet) preservation of scapula element portions

Element	NISP	Comp	Head	Blade	Indet	Indet head	Indet blade
Scapula	30	0	7	12			1

Table 13 Red deer (including sp. indet) preservation of pelvic element portions

Element	NISP	Comp	Acetabulum	Ilium	Ischium	Pubis	Indet
Pelvis	1	0		1			

Table 14 Red Deer (including sp. indet) preservation of appendicular element potions

Element	NISP	Comp[11]	Prox	Prox shaft	Mid-shaft	Dist shaft	Dist	Indet [12]epiphysis	Indet dist epiphysis	Indet prox epiphysis	Indet shaft	indet
Humerus	10	0	1			1	2		1		3	
Radius	11	0	2	3	2	3		1			3	
Ulna	4	0	1	1	1						1	
Metacarpal	14	0	2	2	1	1					7	
Femur	13	0	1		1	2	2		1		6	
Patella	1	1										
Tibia	22	0	1	2	2	1	3				14	
Metatarsal	32	0	6	9	5	5	2				9	
Metapodial	14	0	1								11	

Table 15 Red deer (including sp. indet) preservation of carpals and tarsals

Element	NISP	Comp
Astragalus	2	2
Calcaneum	2	2
Lunate	2	2
Navicular	3	2
Magno-trapezoid	1	1
Scaphoid	1	1
Malleolus	3	3
Uniciform	1	1
Cuniform	2	2

---

[11] Comp- abbreviation for 'Complete'

[12] Indet- abbreviation for 'Indeterminate'

(Table 15 contined)

Sesamoid	1	1
Tarsal	1	1

Table 16 Red deer (including sp. indet) preservation of phalanx element portions

Element	NISP	Comp	Prox	Shaft	Dist	Indet epiphysis
1st phalanx	1	0				1
2nd phalanx	5	2	4	3	4	
3rd phalanx	1	0	1	1	1	

Table 17 Predator-scavenger modification on red deer skeleton; includes cervidae sp. indet

Element	NISP
axis	1
rib	1
scapula	2
femur	2
tibia	1
metatarsal	3
calcaneum	1

Table 18 Hominin modification on red deer skeleton; includes cervidae sp. indet

Element	NISP
antler/horncore	1
cranial	4
maxilla w/o teeth	16
premolar	1
molar	1
atlas	3
axis	1
cervical vertebra	5
thoracic vertebra	8
lumbar vertebra	4
vertebra	1
scapula	24
humerus	1
radius	6
pelvis	2
femur	4
tibia	6
metatarsal	6
metapodial	1
astraglaus	1
tarsal	1
1st phalanx	1
2nd phalanx	1

Table 19 Fallow deer NISP, MNE and MNI values

Element	NISP	MNE	MNI
antler/horncore			
cranial			
mandible w teeth			
mandible w/o teeth			
maxilla w teeth			

(Table 19 continued)

maxilla w/o teeth			
deciduous incisor			
decidous premolar			
canine			
incisor			
premolar	1	1	1
molar	1	1	1
upper teeth	3	3	1
lower teeth	5	5	1
tooth			
atlas			
axis			
cervical vertebra			
thoracic vertebra			
lumbar vertebra			
sacral vertebra			
caudal vertebra			
vertebra			
rib			
scapula	1	1	1
humerus			
radius			
ulna			
radius+ulna			
metacarpal			
pelvis			
femur			
patella			
tibia			
metatarsal			
metapodial	1	1	1
astraglaus			
calcaneum			
malleolus			
uniciform	1	1	1
lunate			
cunifrom			
navicular			
sesamoid			
carpal			
tarsal			
magno-trapezoid			
scaphoid			
magnum	2	1	1
1st phalanx			
2nd phalanx			
3rd phalanx			
indet cranial frag			
indet tooth frag			
indet humerus			
indet long bone frag			
indet frag			

Table 20 Roe deer NISP, MNE and MNI values

Element	NISP	MNE	MNI
antler/horncore	8		
cranial			
mandible w teeth	8	3	2
mandible w/o teeth	2		
maxilla w teeth			
maxilla w/o teeth			
deciduous incisor			
decidous premolar	2	2	2
canine			
incisor	4	4	2
premolar	3	3	2
molar	29	3	2
upper teeth	7	5	2
lower teeth	13	10	2
tooth	1	1	1
atlas			
axis			
cervical vertebra			
thoracic vertebra			
lumbar vertebra			
sacral vertebra			
caudal vertebra			
vertebra			
rib			
scapula	1	1	1
humerus	2	2	1
radius	2	2	1
ulna			
radius+ulna			
metacarpal	1	1	1
pelvis	1	1	1
femur	2	2	1
patella			
tibia	2	2	2
metatarsal	24	2	1
metapodial	2	1	1
astraglaus			
calcaneum	3	3	3
malleolus			
uniciform			
lunate			
cuniform			
navicular	1	1	1
sesamoid			
carpal			
tarsal			
1st phalanx	2	1	1
2nd phalanx	1	1	1
3rd phalanx			
indet cranial frag			
indet tooth frag			
indet humerus			

(Table 20 continued)

indet long bone frag			
indet frag			

Table 21 Roe deer preservation of mandibular portions

Element	NISP	Comp	Tooth row	Diastema	Coronoid process	Anterior ascending ramus	Condyle	Ascending ramus	Corpus mandibulae	Indet
Mandible	10	0	6				1	1		

Table 22 Roe deer preservation of appendicular skeletal element portions

Element	NISP	Comp	Prox	Prox shaft	Mid-shaft	Dist shaft	Dist	Indet epiphysis	Indet dist epiphysis	Indet prox epiphysis	Indet shaft	indet
Humerus	2	0				1					1	
Radius	2	0			1	1	1				1	
Metacarpal	1	0									1	
Femur	2	0	1								1	
Tibia	2	0		1	1	1	2					
Metatarsal	24	0	3	1	2	1					7	
Metapodial	2	0									1	
1st phalanx	2	0	1				1					
2nd phalanx	1	0					1					

Table 23 Roe deer preservation of scapula portions

Element	NISP	Comp	Head	Blade	Indet	Indet head	Indet blade
Scapula	1	0	1	1			

Table 24 Roe deer preservation of pelvic portions

Element	NISP	Comp	Acetabulum	Ilium	Ischium	Pubis	Indet
Pelvis	1	0	1	1			

Table 25 Giant deer NISP values

Element	NISP
upper premolar	2
upper molar	6

Table 26 Horse NISP, MNE and MNI values

Element	NISP	MNE	MNI
cranial	5		
stylohyoid	1	1	1
mandible w teeth	1	1	1
mandible w/o teeth	35	1	1
maxilla w teeth	1	1	1
maxilla w/o teeth			
deciduous incisor			
decidous premolar			

(Table 26 continued)

canine			
incisor			
premolar	5	4	2
molar	11	11	5
upper teeth			
lower teeth	1	1	1
cheek tooth	5	1	1
tooth	2	1	1
atlas	5	3	3
axis	1	1	1
cervical vertebra	5		
thoracic vertebra	1		
lumbar vertebra	7		
sacral vertebra			
caudal vertebra			
vertebra			
rib	1		
scapula	5	2	2
humerus	5	1	1
radius	15	1	1
ulna			
radius+ulna			
metacarpal			
pelvis	14	2	2
femur	9	2	1
patella			
tibia	4	1	1
metatarsal			
metapodial			
astraglaus			
calcaneum			
malleolus			
uniciform			
lunate			
cunifrom			
navicular			
sesamoid			
carpal			
tarsal			
magno-trapezoid			
scaphoid			
magnum			
1st phalanx			
2nd phalanx			
3rd phalanx	1	1	1
indet cranial frag			
indet tooth frag	1		
indet humerus			
indet long bone frag			
indet metapodial			
indet frag	2		

Table 27 Horse preservation of vertebral portions

Element	NISP	Comp	Zone 1	Zone 2	Zone 3	Zone 4	Indet
Atlas	5	0	3	3			1
Axis	1	0		1			
Cervical	5	0	3	2	4	2	1
Thoracic	1	0		1	1		
Lumbar	7	0	1		3	2	

Table 28 Horse preservation of scapula portions

Element	NISP	Comp	Head	Blade	Indet	Indet head	Indet blade
Scapula	5	0	2	3			1

Table 29 Horse preservation of appendicular skeleton

Element	NISP	Comp	Prox	Prox shaft	Mid-shaft	Dist shaft	Dist	Indet epiphysis	Indet dist epiphysis	Indet shaft	Indet
Humerus	5	0				2	1			2	
Radius	15	0								15	
femur	9	0		2	1					3	
tibia	4	0					1			1	
3rd phalanx	1	1	1	1	1	1	1				

Table 30 Horse preservation of pelvic portions

Element	NISP	Comp	Acetabulum	Ilium	Ischium	Pubis	Indet
Pelvis	14	0	3	2	2	3	1

Table 31 Predator-scavenger modification on horse skeletal elements

Element	NISP
mandible w/o teeth	3
cervical vertebra	1
radius	1
pelvis	7
femur	1

Table 32 Hominin modification on horse skeletal elements

Element	NISP
maxilla w/o teeth	4
premolar	2
molar	4
lumbar vertebra	2
scapula	1
humerus	2
radius	8
pelvis	8
femur	8
tibia	2

Table 33 Bison NISP, MNE and MNI (includes Bovid sp. indet)

Element	NISP	MNE	MNI
antler/horncore			
cranial			
mandible w teeth			
mandible w/o teeth			
maxilla w teeth			
maxilla w/o teeth			
deciduous incisor			
decidous premolar			
canine			
incisor			
premolar			
molar	1	1	1
upper teeth			
lower teeth			
tooth			
atlas			
axis			
cervical vertebra	3		
thoracic vertebra	1		
lumbar vertebra	1		
sacral vertebra			
caudal vertebra			
vertebra			
rib	1		
scapula			
humerus	1	1	1
radius	1	1	1
ulna			
radius+ulna	2	1	1
metacarpal	2	1	1
pelvis			
femur	1	1	1
patella			
tibia	3	2	1
metatarsal			
metapodial			
astraglaus			
calcaneum			
malleolus			
uniciform			
lunate			
cuniform	1	1	1
navicular			
sesamoid			
carpal			

(Table 33 continued)

tarsal			
1st phalanx			
2nd phalanx	1	1	1
3rd phalanx			
indet cranial frag			
indet tooth frag			
indet humerus			
indet long bone frag			

Table 34 Distribution of bovid species throughout Boxgrove major contexts

	Bison Priscus	Bovidae sp indet
unit 2		
unit 3		
unit 3/4		
unit 3c		4
unit 3x		
unit 4		
unit 4a		
unit 4b		
unit 4b (2l)		
unit 4c	5	2
unit gc		
gully fill		
unit 4d		
unit 4e		
unit 4.3c		
unit 4.4u		
unit 4u		2
unit 4u/4.3c		
unit 5		
unit 5a		
unit lgc		
unit 5a/4c		
unit 5b		
unit 5b/6		
unit 5c		
unit 6		1
unit 7		
unit 8	3	1
unit 11		

Table 35 Bison preservation of specific vertebral portions

Element	NISP	Comp	Zone 1	Zone 2	Zone 3	Zone 4	Indet
Cervical	3	0	3	3	3	1	
Thoracic	3	0	2	2	2	2	
Lumbar	1	0	1	1	1		

Table 36 Bison preservation of appendicular skeleton

Element	NISP	Comp	Prox	Prox shaft	Mid-shaft	Dist shaft	Dist	Indet epiphysis	Indet dist epiphysis	Indet prox epiphysis	Indet shft	Indet
Humerus	1	0		1	1	1	1					
Radius	3	0	1	1	2	1	1					
Metacarpal	2	0	1	1		1	1					
Femur	1	0									1	
Tibia	3	0				1	1					
2nd phalanx	1	1	1	1	1	1	1					

Table 37 Rhinoceros NISP, MNE and MNI values

Element	NISP	MNE	MNI
cranial	1	1	1
mandible w teeth	1	1	1
mandible w/o teeth	1	1	1
maxilla w teeth	5	1	1
maxilla w/o teeth			
deciduous incisor			
decidous premolar	2	2	2
canine			
incisor			
premolar	1	1	1
molar	1	1	1
upper teeth			
lower teeth	1	1	1
tooth	1	1	1
atlas			
axis			
cervical vertebra	1		
thoracic vertebra			
lumbar vertebra			
sacral vertebra			
caudal vertebra			
vertebra	1	1	1
rib			
scapula	1	1	1
humerus	5	1	1
radius			
ulna	2	2	1
radius+ulna			
rhino metacarpal	1	1	1
pelvis	8	2	2
femur			
patella	1	1	1
tibia	1	1	1
rhino metatarsal			
rhino metapodial			
astraglaus	1	1	1
calcaneum	1	1	1
malleolus			

(Table 37 continued)

uniciform			
lunate			
cunifrom			
navicular			
sesamoid			
carpal			
tarsal			
magno-trapezoid			
scaphoid			
magnum	1	1	1
1st phalanx			
2nd phalanx			
3rd phalanx	1	1	1
indet cranial frag			
indet tooth frag			
indet humerus			
indet femur			
indet tibia			
indet long bone frag			
indet metapodial			
indet phalanx			
indet frag			

Table 38 Rhinoceros preservation of pelvic portions

Element	NISP	Comp	Acetabulum	Ilium	Ischium	Pubist	Indet
Pelvis	8	0	1	3	2	2	

Table 39 Rhinoceros preservation of scapula portions

Element	NISP	Comp	Head	Blade	Indet	Indet head	Indet blade
Scapula	1	0	1	1			

Table 40 Rhinoceros preservation of appendicular skeletal

Element	NISP	Comp	Prox	Prox shaft	Mid-shaft	Dist shaft	Dist	Indet epiphysis	Indet dist epiphysis	Indet prox epiphysis	Indet shaft	indet
Humerus	1	0		1	1	1	1					
Ulna	2	0	1	1	1	2	2					
Metacarpal	1	0	1	1	1	1	1					
Femur	1	0					1					
Tibia	1	0				1						
3rd phalanx	1	1	1	1	1	1	1					

Table 41 Hominin modification on rhino skeleton

Element	NISP
cranial	1
mandible w/o teeth	1
maxilla w teeth	5
molar	1
ulna	2
pelvis	6
tibia	1
calcaneum	1
magnum	1

Table 42 Large mammal NISP values

Element	NISP
antler/horncore	
cranial	11
mandible w teeth	
mandible w/o teeth	12
maxilla w teeth	
maxilla w/o teeth	
deciduous incisor	
decidous premolar	1
canine	
incisor	
premolar	
molar	
upper teeth	
lower teeth	
tooth	
atlas	
axis	
cervical vertebra	
thoracic vertebra	3
lumbar vertebra	
sacral vertebra	
caudal vertebra	
vertebra	23
rib	46
scapula	3
humerus	4
radius	5
ulna	1
radius+ulna	
metacarpal	
pelvis	2
femur	5
patella	
tibia	
metatarsal	
metapodial	
astraglaus	
calcaneum	
malleolus	
uniciform	

(Table 42 continued)

lunate	
cunifrom	
navicular	
sesamoid	1
carpal	
tarsal	
magno-trapezoid	
scaphoid	
magnum	
1st phalanx	1
2nd phalanx	
3rd phalanx	
indet cranial frag	10
indet tooth frag	1
indet humerus	
indet femur	1
indet tibia	
indet long bone frag	87
indet metapodial	
indet phalanx	
indet frag	148

Table 43 Indeterminate species NISP

Element	NISP
antler/horncore	
cranial	1
mandible w teeth	
mandible w/o teeth	2
maxilla w teeth	
maxilla w/o teeth	
deciduous incisor	
decidous premolar	
canine	
incisor	
premolar	
molar	
upper teeth	
lower teeth	
tooth	
atlas	
axis	
cervical vertebra	
thoracic vertebra	
lumbar vertebra	
sacral vertebra	
caudal vertebra	
vertebra	2
rib	
scapula	3
humerus	
radius	
ulna	
radius+ulna	

(Table 43 continued)

metacarpal	
pelvis	
femur	
patella	
tibia	
metatarsal	
metapodial	
astraglaus	
calcaneum	
malleolus	
uniciform	
lunate	
cunifrom	
navicular	
sesamoid	
carpal	
tarsal	1
magno-trapezoid	
scaphoid	
magnum	
1st phalanx	
2nd phalanx	
3rd phalanx	
indet cranial frag	8
indet tooth frag	
indet humerus	1
indet tibia	1
indet long bone frag	103
indet metapodial	4
indet phalanx	1
indet frag	195

Appendix 3 – Lynford results and analysis tables

Table 1 Detailed context composition for each Association

Component	Subdivision	Context Numbers
Association B-iii		20023, 20025, 20026, 20216, 20020, 20142, 20028, 20123, 20015, 20018, 20199, 20213, 20216, 20016, 20066, 20012, 20115, 20125/20211, 20195, 20394
Association B-ii	B-ii:01	20133, 20245, 20345, 20381, 20004, 20347, 20369, 20383, 20384, 20139, 20255, 20346, 20363, 20364
	B-ii:02	20031, 20246, 20355, 20371, 20386, 20387, 20390, 20403, 20402
	B-ii:03a	20003, 20021, 20248, 20250, 20252, 20258
	B-ii:03b	20347, 20374, 20376, 20408, 2003b, 20055, 20243, 20348
	B-ii:03c	20131, 20132, 20134, 20257, 20366, 20367, 20368, 20370, 20392
	B-ii:03d	20250, 20249, 20251
	B-ii:03e	20053, 20140, 20247, 20372
	B-ii:04a	20070c, 20171b
	B-ii:04b	20070b, 20070a, 20005, 20071, 20072, 20116, 20120/20136, 20170a, 20351, 20056, 20345, 20118/20119
Association B-i	B-i:01	20332, 20334
	B-i:02	20362, 20361
	B-i:03	20051, 20129, 20130, 20379, 20398, 20078, 20400, 20405

Table 2 NISP counts for each species

Species	NISP
Mammuthus primigenius	2341
Coelodonta antiquitatis	46
Large mammal	58
Bison priscus	4
Equus ferus	7
Deer/Horse size	2
Rangifer tarandus	103
Deer sized	2
Indet	935
Total	**3498**

Table 3 Distribution of species within Associations
N.B 154 specimens from contexts not assigned to scheme due to ongoing work with the stratigraphy.

	Association			
Species	**B-i**	**B-ii**	**B-iii**	**Total**
Mammuthus primigenius	14	2206	16	**2236**
Coelodonta antiquitatis	0	46	0	**46**
Bison priscus	0	4	0	**4**
Rangifer tarandus	9	94	0	**103**
Deer sized	0	2	0	**2**
Equus ferus	0	7	0	**7**
Large mammal	1	57	0	**58**
Indet	7	881	0	**888**
Total	**31**	**3297**	**16**	**3344**

Table 4 Weathering of faunal remains

Weathering Code	**Total**
0	329
1	786
2	598
3	1007
4	651
5	127
Total	**3498**

Table 5 Weathering of faunal remains by Association and Facies
N.B *154* specimens from contexts not assigned to scheme due to ongoing work with the stratigraphy.

Association	**Facies**	**Weathering codes (using Behrensmeyer, 1978)**						
		0	**1**	**2**	**3**	**4**	**5**	**TOTAL**
B-i	*B-i:01*	0	0	0	0	0	0	0
	B-i:02	0	0	0	0	0	0	0
	B-i:03	0	1	2	5	16	7	31
B-i Total		**0**	**1**	**2**	**5**	**16**	**7**	**31**
B-ii	*B-ii:01*	18	25	43	91	44	11	**232**
	B-ii:02		2		1	6		**9**
	B-ii:03a	288	720	493	842	534	68	**2945**
	B-ii:03b				1		4	**5**
	B-ii:03c	7	2	16	21	11	3	**60**
	B-ii:03d		3		2			**5**
	B-ii:03e	1	5	4	9	10	1	**30**
	B-ii:04a	0	0	0	0	0	0	**0**
	B-ii:04b	1	3		1	1	5	**11**
B-ii Total		**315**	**760**	**556**	**968**	**606**	**92**	**3297**
B-iii		0	1	3	1	1	10	16
B-iii Total		**0**	**1**	**3**	**1**	**1**	**10**	**16**

Table 6 Weathering of species at Lynford

Species	Weathering Codes					
	0	1	2	3	4	5
Mammuthus primigenius	165	490	442	662	488	94
Coelodonta antiquitatis	13	29		3	1	
Bison priscus		2	1	1		
Rangifer tarandus	16	33	21	8	19	6
Deer sized			1	1		
Equus ferus		1	4	2		
Large mammal	3	12	7	29	7	
Indet	132	219	122	301	134	27

Table 7 Natural modification across Lynford species

Species	Abrasion	Cracking	Hydraulic action	Scratch marks	Pitting
Mammuthus primigenius	53	1096	13	206	885
Coelodonta antiquitatis	0	8	0	2	10
Large mammal	2	36	1	7	27
Bison priscus	1	3	1	1	4
Equus ferus	0	7	0	5	5
Rangifer tarandus	6	54	2	13	51
Deer/Horse size	0	1	0	1	1
Deer sized	0	2	0	1	2
Indet	29	479	8	58	468

Table 8 Root etching on Lynford species

Species	heavy etching (50%< of bone surface)	slight etching (<25% bone surface)	Total
Mammuthus primigenius		19	19
Bison priscus		1	1
Rangifer tarandus	3		3
Equus ferus		1	1
Large mammal		2	2
Indet	3	3	6
Total	**6**	**26**	**32**

Table 9 Mammoth NISP

Element	NISP
cranial	26
indet cranial frag	641
tusk	974
mandible w teeth	1
mandible w/o teeth	12
maxilla w teeth	1
maxilla w/o teeth	2
upper molar	17
lower molar	13
lower tooth	1
molar	94
stylohyoid	3
atlas	1

(Table 9 continued)

Axis	1
thoracic vertebra	10
lumbar vertebra	1
caudal vertebra	2
vertebra	26
rib	224
sternum	3
scapula	5
humerus	9
radius	1
ulna	5
pelvis	9
femur	16
tibia	3
cuniform	2
magnum	2
2nd phalanx	1
3rd phalanx	1
indet long bone frag	175
indet frag	58
Total	**2340**

Table 10 Mammoth NISP, MNE and MNI values

Element	NISP	MNE	MNI
Mandible w teeth	1	1	1
Mandible w/o teeth	12	1	1
Maxilla w teeth	1	1	1
Maxilla w/o teeth	2	1	1
Stylohyoid	3	2	1
M_2	3	3	2
M_3	8	2	1
Indet lower molar	2	1	1
M^1	4	3	3
M^2	3	1	1
M^3	10	3	3
Atlas	1	1	1
Axis	1	1	1
Sternum	3	1	1
Scapula	5	1	1
Humerus	9	1	1
Radius	2	1	1
Ulna	5	2	1
Pelvis	9	2	1
Femur	16	1	1
Tibia	3	1	1
Magnum	2	1	1
Cuniform	2	1	1
2nd Phalanx	1	1	1
3rd Phalanx	1	1	1

Table 11 Mammoth appendicular skeleton portion survival

Element	NISP	Comp	Prox	Prox shaft	Mid-shaft	Dist shaft	Dist	Indet epiphysis	Indet dist epiphysis	Indet prox epiphysis	Indet shaft	Indet
Humerus	9	0		1	1	2					1	
Radius	2	0				1	1					
Ulna	5	0		2	1							
Femur	16	0	2	3	5	5						
Tibia	3	0		1	1	1	1				2	
2nd phalanx	1	1	1	1	1	1	1					
3rd phalanx	1	1	1	1	1	1	1					

Table 12 Mammoth vertebral portion survival

Element	NISP	Comp	Zone 1	Zone 2	Zone 3	Zone 4
Atlas	1	1	1	1	1	1
Axis	1	0	1	1	1	1
Caudal vertebra	2	0	2	1		1
Thoracic vertebra	6	2	6	5	5	6
Vertebra	26	0	12	5	5	7

Table 13 Mammoth rib portion survival

Element	NISP	Complete	Zone 1	Zone 2	Zone 3	Indet shaft
Rib	224	5	51	49	39	100

Table 14 Distribution of predator-scavenger modification on mammoth remains

Element	NISP
cranial	1
indet cranial frag	4
sternum	1
vertebra	2
rib	24
humerus	2
ulna	5
pelvis	3
femur	8
tibia	1
magnum	1
2nd phalanx	1
indet long bone frag	11

Table 15 Woolly rhino NISP, MNE and MNI values

Element	NISP	MNE	MNI
dp2	1	1	1
dp3	1	1	1
dp4	1	1	1
lower molar	26	1	1
lower premolar	1	1	1
upper premolar	1	1	1
upper molar	3	1	1
molar	2	1	1
humerus	8	1	1
pelvis	1	1	1
tibia	1	1	1

Table 16 Distribution of predator-scavenger modification on woolly rhino remains

Element	NISP
pelvis	1
tibia	1

Table 17 Distribution of hominin modification on woolly rhino remains

Element	NISP
lower molar	2

Table 18 Reindeer NISP, MNE and MNI values

Element	NISP	MNE	MNI
antler	7		
antler isolated	61		
cranial	1	1	1
mandible w/o teeth	2	1	1
deciduous premolar	1	1	1
lower premolar	1	1	1
lower molar	1	1	1
lumbar vertebra	1		
vertebra	2		
rib	2		
humerus	3	1	1
radius	1	1	1
metacarpal	1	1	1
pelvis	2	2	1
femur	5	1	1
tibia	3	1	1
metatarsal	2	1	1
2nd phalanx	2	2	2
indet tibia	1		
indet long bone frag	4		
Total	**103**		

Table 19 Reindeer appendicular skeleton portion survival

Element	NISP	Comp	Prox	Prox shaft	Mid-shaft	Dist shaft	Dist	Indet epiphysis	Indet dist epiphysis	Indet prox epiphysis	Indet shaft	indet
humerus	3	0									3	
radius	1	0	1	1								
metacarpal	1	1	1	1	1	1	1					
femur	4	0	1						2		1	
tibia	3	0									3	
2^{nd} phalanx	2	1	2	2	2	1	1					

Table 20 Distribution of predator-scavenger modification across reindeer skeleton

Element	NISP
antler isolated	7
femur	3
indet tibia	1
2nd phalanx	1
indet long bone frag	1
Total	**13**

Table 21 Distribution of hominin modification across reindeer skeleton

Element	NISP
humerus	1
femur	1
metatarsal	1
indet long bone frag	3
Total	**6**

Table 22 Horse NISP, MNE and MNI values

Element	NISP	MNE	MNI
lower molar	1	1	1
upper incisor	1	1	1
indet cheek tooth	1	1	1
molar	1	1	1
femur	1	1	1
astragalus	1	1	1
calcaneum	1	1	1
Total	**7**		

Table 23 Bison NISP, MNE and MNI values

Element	NISP	MNE	MNI
humerus	2	2	1
radius	1	1	1
metatarsal	1	1	1

Table 24 Indeterminate species NISP

Element	NISP
indet cranial frag	389
mandible w/o teeth	1
molar	1
tooth	1
vertebra	1
rib	47
radius	2
femur	1
indet femur	1
indet tibia	1
indet long bone frag	28
indet frag	462
Grand Total	**935**

Table 25 Large mammal NISP

Element	NISP
indet cranial	10
vertebra	1
rib	18
scapula	6
indet radius	4
indet long bone	16
indet frag	3
Total	**58**

Appendix 4 – Swanscombe results and analysis

Table 1 Species NISP and % of total at Swanscombe

Species	**NISP**	**%**
Palaeoloxodon antiquus	6	1.2
Stephanorhinus hemitoechus	1	0.2
Stephanorhinus kirchbergensis	4	0.8
Stephanorhinus sp.	7	1.4
Elephant sp indet	3	0.6
Bison priscus	1	0.2
Bos primigenius	1	0.2
Bovidae sp indet	41	8.1
Megaloceros giganteus	1	0.2
Cervus elaphus	16	3.2
Dama dama	138	27.4
Cervidae sp indet	279	55.4
Indet	6	1.2
Total	**504**	**100.0**

Table 2 Distribution of species throughout Swanscombe contexts

Species/Context	*Palaeoloxodon antiquus*	Elephant sp indet	*Stephanorhinus hemitoechus*	*Stephanorhinus kirchbergensis*	Stephanorhinus sp.	*Megaloceros giganteus*	*Bison priscus*	*Bos primigenius*	Bovidae sp indet	*Cervus elaphus*	*Dama dama*	Cervidae sp indet	Indet	Total
Indet									1		13	21	1	**36**
Middle gravel									1		2			**3**
Lower middle gravel	1													**1**
Lower loam undifferentiated					1							2		**3**
Lower loam weathered surface									6		1	12		**19**
Weathered lower loam					2	1	1			7	3	14	1	**29**
Lower loam main body	1	1							1	5	61	118		**187**
Lower loam sandy horizon				1					10		1	1		**13**
Base of lower loam											2			**2**
Lower loam/lower gravel junction					1				2	1	4	32	4	**44**
Lower gravel midden	4	1	2	1	3				9	1	38	25		**84**
Lower gravel		1		1				1	11	2	13	54		**83**
Total	**6**	**3**	**2**	**3**	**7**	**1**	**1**	**1**	**41**	**16**	**138**	**279**	**6**	**504**

Table 3 General weathering of the Swanscombe faunal assemblage

Weathering Stage	NISP	% of total
0	197	39.1
1	219	43.5
2	77	15.3
3	9	1.8
4	2	0.4

Table 4 Weathering of faunal material throughout the Swanscombe contexts
N.B figures for Lower Loam surface have been incorporated into Lower Loam main body

	Weathering Stage					
Context	**0**	**1**	**2**	**3**	**4**	**Total**
Indet	20	14		1	1	**36**
Middle gravel		2				**2**
Lower middle gravel		1			1	**2**
Lower loam undifferentiated	1	2				**3**
Lower loam weathered surface	14	3	2			**19**
Weathered lower loam	6	11	10			**27**
Lower loam main body	65	99	32	3		**199**
Lower loam sandy horizon	3					**3**
Base of lower loam	2					**2**
Lower loam/lower gravel junction	27	13	4			**44**
Lower gravel midden	35	37	8	4		**84**
Lower gravel	24	37	21	1		**83**
Total	**197**	**219**	**77**	**9**	**2**	**504**

Table 5 Weathering of faunal species

	Weathering Stage					
Species	**0**	**1**	**2**	**3**	**4**	**Total**
Palaeoloxodon antiquus	2	1	1	1	1	**6**
Stephanorhinus hemitoechus		1				**1**
Stephanorhinus kirchbergensis	2	1	1			**4**
Stephanorhinus sp.		4	3			**7**
Elephant sp indet		1	1	1		**3**
Bison priscus	1					**1**
Bos primigenius		1				**1**
Bovidae sp indet	18	18	4	1		**41**
Megaloceros giganteus			1			**1**
Cervus elaphus	5	9	2			**16**
Dama dama	67	60	8	2	1	**138**
Cervidae sp indet	97	123	56	3		**279**
Indet	5			1		**6**
Total	**197**	**219**	**77**	**9**	**2**	**504**

Table 6 Distribution of natural modification across major species

Species	abrasion	pitting	cracking	hydraulic action	scartch marks
Palaeoloxodon antiquus	1	6	4	1	2
Stephanorhinus hemitoechus	0	1	1	0	0
Stephanorhinus kirchbergensis	0	4	2	0	0
Stephanorhinus sp.	0	5	6	1	1
Elephant sp indet	0	3	3	0	0
Bison priscus	0	0	0	0	0
Bos primigenius	0	0	1	0	0
Bovidae sp indet	1	10	16	2	4
Megaloceros giganteus	0	1	1	0	1
Cervus elaphus	1	4	5	1	1
Dama dama	2	40	49	7	11
Cervidae sp indet	14	111	118	27	17
Indet	0	1	1	0	0

Table 7 Red deer NISP, MNE and MNI values

Element	NISP	MNE	MNI
antler	1		
maxilla	6	1	1
premolar	1	1	1
molar	3	2	1
humerus	2	2	1
metacarpal	1	1	1
tibia	1	1	1
metatarsal	1	1	1

Table 8 Red deer appendicular skeleton portion survival

Element	NISP	Comp	Prox	Prox shaft	Mid-shaft	Dist shaft	Dist	Indet epiphysis	Indet dist epiphysis	Indet prox epiphysis	Indet shaft	indet
Humerus	2	0				2	2					
Metacarpal	1	1	1	1	1	1	1					
Tibia	1	0					1					
Metatarsal	1	0	1	1	1	1						

Table 9 Fallow deer NISP, MNE and MNI

Element	NISP	MNE	MNI
antler	51		
axis	1	1	1
cranial	1		
mandible	7	7	3
incisor	1	1	1
premolar	1	1	1
molar	18	14	7
lower teeth	5	5	1
upper teeth	7	6	1
scapula	5	3	2
humerus	4	2	2

(Table 9 continued)

radius	5	2	2
metacarpal	3	2	1
femur	3	2	1
tibia	5	4	2
metatarsal	3	1	1
metapodial	2	1	1
1st phalanx	2	2	2
2nd phalanx	8	1	1

Table 10 Fallow deer mandibular portion survival

Element	NISP	Comp	Tooth row	Diastema	Coronoid process	Anterior ascending ramus	Condyle	Ascending ramus	Corpus mandibulae	indet
Mandible	7	0	7	6	2	1	2	3	1	

Table 11 Fallow deer appendicular portion survival

Element	NISP	Comp	Prox	Pox shaft	Mid-shaft	Dist shaft	Dist	Indet epiphysis	Indet dist epiphysis	Indet prox epiphysis	Indet shaft	Indet
Humerus	4	0	3				3	2				
Radius	6	0	2	2	2							
Metacarpal	3	0	3	2	1	1	1	1				
Femur	3	0	3	1	1	1	2	2				
Tibia	5	0	5	1	1		3	4				
Metatarsal	4	1	3	2	3	1	2	1				
Metapodial	1	0	1					1				
1st phalanx	2	2		2	2	2	2	2				
2nd phalanx	8	1		1	1	1	1	1				

Table 12 Fallow deer scapula portion survival

Element	NISP	Comp	Head	Blade	Indet	Indet head	Indet blade
Scapula	5	0	3	3			

Table 13 Cervid sp. indet axial skeleton portion preservation

Element	NISP	Comp	Zone 1	Zone 2	Zone 3	Zone 4
Atlas	3	0	3	3		
Axis	1	1	1	1	1	1
Cervical	1	0	1	1	1	1
Thoracic	5	0	5	1	1	1
Lumbar	2	0	2			
Vertebra	11	0	1	1	1	1

Table 14 Cervid sp. indet scapula portion survival

Element	NISP	Comp	Head	Blade	Indet	Indet head	Indet blade
Scapula	11	0	5	4	1		

Table 15 Cervid sp. indet appendicular skeleton portion preservation

Element	NISP	Comp	Prox	Prox shaft	Mid-shaft	Dist shaft	Dist	Indet epiphysis	Indet dist epiphysis	Indet prox epiphysis	Indet shaft	indet
Humerus	15			2	6	6	3				6	
Radius	10		1	4	4	3	5					
Ulna	3		3	1								
Metacarapal	5		2	4	4	2	1					
Femur	15		6	5	8	6	1				2	
Tibia	10		1	1	6	5	6				2	
Metatarsal	12		1	2	4	2	1				7	
Metapodial	4						2				1	
1st phalanx	3	1	2	2	2	2	2					
3rd phalanx	1	1	1	1	1	1	1					

Table 16 Cervid sp. indet pelvis portion preservation

Element	NISP	Comp	Acetabulum	Ilium	Ischium	Pubis	Indet
Pelvis	8	0	3	1		1	

Table 17 Bovid sp. indet NISP, MNE and MNI values

Element	NISP	MNE	MNI
horn core	15		
cranial	1		
premolar	3	1	1
molar	5	1	1
thoracic vertebra	2		
rib	2		
radius	1	1	1
metacarpal	1	1	1
pelvis	3	2	1
femur	1	1	1
tibia	1	1	1
indet humerus	6		

Table 18 Bovid sp. indet appendicular skeleton portion survival

Element	NISP	Comp	Prox	Prox shaft	Mid-shaft	Dist shaft	Dist	Indet epiphysis	Indet distal epiphysis	Indet proximal epiphysis	Indet shaft	indet
Humerus	6	0										1
Radius	1	0									1	
Metacarpal	1	0	1	1	1							
Femur	1	0	1									
Tibia	1	0				1	1					

Table 19 Elephant NISP, MNE and MNI values

Element	NISP	MNE	MNI
mandible w/o teeth	1	1	1
tooth	1	1	1
cranial	1		
rib	2		
pelvis	2	2	1
calcaneum	1	1	1

Table 20 Stephanorhinus hemitoechus NISP, MNE and MNI values

Element	NISP	MNE	MNI
upper molar	1	1	1

Table 21 Stephanorhinus kirchbergensis NISP, MNE and MNI values

Element	NISP	MNE	MNI
upper molar	1	1	1
cranial	1		
carpal	1	1	1
rhino metacarpal	1	1	1

Table 22 Stephanorhinus sp. indet NISP, MNE and MNI values

Element	NISP	MNE	MNI
cranial	1		
mandible	1	1	1
lower molar	1	1	1
humerus	2	1	1
3rd phalanx	2	2	1

Appendix 5 – Hoxne results and analysis

Table 1 Species NISP and % of total at Hoxne

Species	NISP	% of total NISP
Elephant sp. indet	3	0.6
Dicerorhinus sp.	65	13.2
Megaceros giganteus	33	6.7
Giant Deer size	7	1.4
Cattle size	1	0.2
Cattle/horse sized	3	0.6
Equus ferus	254	51.6
Cervus elaphus	83	16.9
Dama dama	2	0.4
Cervidae sp. indet	22	4.5
Deer sized	7	1.4
Deer/horse sized	12	2.4

Table 2 NISP distribution throughout the Hoxne stratigraphy

Context	NISP
Stratum D	2
1	262
2	85
3	2
4	54
5	50
Indet	37
Total	**492**

Table 3 Distribution of faunal material throughout units at Hoxne

	Context							**Total**
Species	**Stratum D**	**1**	**2**	**3**	**4**	**5**	**indet**	
elephant sp. indet			2		1			**3**
dicerorhinus sp.		1	1		50	11	2	**65**
cattle/horse sized							4	**4**
megaloceros giganteus		29			1	3		**33**
giant deer size						7		**7**
equus ferus	2	155	63		1	25	8	**254**
cervus elaphus		61	18				4	**83**
dama dama		1				1		**2**
cervidae sp. indet		15	1	2	1	3		**22**
deer/horse sized							19	**19**
Total	**2**	**262**	**85**	**52**	**15**	**41**	**35**	**492**

Table 4 Weathering of material throughout Hoxne contexts

	Weathering Stage				
Context	**0**	**1**	**2**	**3**	**Total**
1	46	23	7		**76**
2	6	3	6		**15**
3	121	46	20		**187**
4			2		**2**
5	1		2		**3**
6					
7	36	2			**38**
8	3				**3**
9	1				**1**
indet	37	36	81	13	**167**
Total	**251**	**110**	**118**	**13**	**492**

Table 5 Weathering of species throughout the Hoxne contexts

	Weathering Stage				
Species	**0**	**1**	**2**	**3**	**Total**
Elephant sp. indet	1		2		**3**
Dicerorhinus sp.	13	2	50		**65**
Megaceros giganteus	29		4		**33**
Giant Deer size	7				**7**
Cattle sized		1			**1**
Cattle/Horse Sized		2	1		**3**
Equus ferus	149	55	40	10	**254**
Cervus elaphus	35	40	8		**83**
Dama dama	1	1			**2**
Cervidae sp indet	15	2	5		**22**
Deer sized	1	2	4		**7**
Deer/Horse size		5	4	3	**12**
Total	**251**	**110**	**118**	**13**	**492**

Table 6 Distribution of natural modification across fauna from Hoxne

Species	**abrasion**	**cracking**	**hydraulic action**	**pitting**	**scratch marks**
Elephant sp. indet		1		2	
Dicerorhinus sp.		3		6	
Megaceros giganteus	1	1		1	
Giant Deer size		0		0	
Cattle sized		1		1	
Cattle/Horse Sized		2			
Equus ferus	8	78	1	48	5
Cervus elaphus		13	1	4	1
Dama dama		1			
Cervidae sp indet		5		2	
Deer sized		5		4	
Deer/Horse size		5		4	
Total	**9**	**115**	**2**	**72**	**6**

Table 7 Red deer NISP, MNE and MNI values

Element	NISP	MNE	MNI
antler/horncore	4		
cranial	10		
mandible w teeth	21	2	1
mandible w/o teeth			
maxilla w teeth	1	1	1
maxilla w/o teeth			
deciduous incisor			
decidous premolar			
canine			
incisor	4	4	1
premolar	1	1	1
molar	7	1	1
upper teeth			
lower teeth	3	1	1
tooth			
atlas			
axis			
cervical vertebra			
thoracic vertebra			
lumbar vertebra			
sacral vertebra			
caudal vertebra			
vertebra			
rib			
scapula	7	1	1
humerus			
radius	4	2	1
ulna			
radius+ulna			
metacarpal	3	1	1
pelvis	2	1	1
femur	1	1	1
patella			
tibia	3	1	1
metatarsal	1	1	1
metapodial			
astraglaus	1	1	1
calcaneum			
malleolus			
uniciform			
lunate			
cunifrom	1	1	1
navicular			
sesamoid			
carpal	1	1	1
tarsal			
magno-trapezoid			
scaphoid			
1st phalanx	3	1	1
2nd phalanx	2	2	2
3rd phalanx			
indet cranial frag			

(Table 7 continued)

indet tooth frag			
indet humerus			
indet long bone frag			
indet frag			
indet tibia	3		

Table 8 Red deer appendicular skeleton portion survival

Element	NISP	Comp	Prox	Prox shaft	Mid-shaft	Dist shaft	Dist	Indet epiphysis	Indet dist epiphysis	Indet prox epiphysis	Indet shaft	indet
Humerus												
Radius	4	1	3	1	1	2	2					
Metacarpal	3	0			1	1	1				1	
femur	1	0	1	1		1	1					
Tibia	3	0			1	1	1					
Metatarsal	1	0										
1st phalanx	3	0	1	1		1	1					
2nd phalanx	2	1	1	1	1	1	1					

Table 9 Red deer scapula element portion survival

Element	NISP	Comp	Head	Blade	Indet	Indet Head	Indet blade
Scapula	7	0	1	1			

Table 10 Red deer pelvis element portion survival

Element	NISP	Comp	Acetabulum	Ililum	Ischium	Pubis	Indet
Pelvis	2			1			

Table 11 Fallow deer NISP, MNE and MNI values

Element	NISP	MNE	MNI
premolar	1	1	1
tibia	1	1	1

Table 12 Giant deer NISP, MNE and MNI values

Element	NISP	MNE	MNI
antler	4		
premolar	1	1	1
2nd phlanax	1	1	1
indet cranial frag	25		

Table 13 Cervid sp. indet NISP, MNE and MNI values

Element	NISP	MNE	MNI
antler/horncore	1		
cranial			
mandible w teeth			
mandible w/o teeth	1	1	1
maxilla w teeth			
maxilla w/o teeth			
deciduous incisor			
decidous premolar			
canine			
incisor			
premolar			
molar			
upper teeth			
lower teeth			
tooth			
atlas			
axis			
cervical vertebra			
thoracic vertebra			
lumbar vertebra			
sacral vertebra			
caudal vertebra			
vertebra			
rib			
scapula			
humerus	1	1	1
radius			
ulna			
radius+ulna			
metacarpal			
pelvis			
femur	10	1	1
patella			
tibia			
metatarsal			
metapodial	6	1	1
astraglaus			
calcaneum			
malleolus			
uniciform			
lunate			
cunifrom			
navicular	1	1	1
sesamoid			
carpal			
tarsal			
magno-trapezoid			
scaphoid			
1st phalanx			
2nd phalanx			
3rd phalanx			
indet cranial frag			

(Table 13 continued)

indet tooth frag			
indet humerus			
indet long bone frag			
indet frag			
indet tibia	2		

Table 14 Horse NISP, MNE and MNI values

Element	NISP	MNE	MNI
cranial	4		
stylohyoid			
mandible	23	3	3
maxilla w teeth	5		
maxilla w/o teeth			
deciduous incisor			
decidous premolar	4	4	2
canine	1	1	1
incisor	16	5	2
premolar	20	15	9
molar	23	6	5
upper teeth			
lower teeth	1		
cheek tooth	80		
tooth	1		
atlas			
axis			
cervical vertebra			
thoracic vertebra			
lumbar vertebra			
sacral vertebra	1		
caudal vertebra			
vertebra	1		
rib	8		
scapula	2	1	1
humerus	3	2	1
radius	4	1	1
ulna	1	1	1
radius+ulna	1	1	1
metacarpal	3	3	2
pelvis	8	2	2
femur	2	1	1
patella	1	1	1
tibia	1	1	1
metatarsal	7	1	1
metapodial			
astraglaus	1	1	1
calcaneum			
malleolus			
uniciform			
lunate			
cunifrom			
navicular			
sesamoid	2	2	2
carpal	5	5	5

(Table 14 continued)

tarsal	1	1	1
magno-trapezoid			
scaphoid			
magnum			
1st phalanx	1	1	1
2nd phalanx	5	4	3
3rd phalanx	4	3	3
indet cranial frag			
indet tooth frag	7		
indet humerus			
indet tibia	1		
indet long bone frag			
indet metapodial			
indet frag			

Table 15 Horse mandible portion survival

Element	NISP	Comp	Diastema	Coronoid process	Anterior ascending	Condyle	Ascending ramus	Corpus mandibulae	indet
Mandible	23	0	1	2		3	1		1

Table 16 Horse axial skeleton portion survival

Element	NISP	Comp	Zone 1	Zone 2	Zone 3	Zone 4	Indet
Sacral vertebra	1	0	1	1			
Vertebra	1	0	1	1	1		

Table 17 Horse appendicular skeleton portion survival

Element	NISP	Comp	Prox	Prox shaft	Mid-shaft	Dist shaft	Dist	Indet epiphysis	Indet distal epiphysis	Indet prox epiphysis	Indet shaft	indet
Humerus	3					1	2	1				
Radius	5			1	1	1	1	1			1	
Ulna	1			1	1	1	1					
Metacarpal	3	1	2	2	2	1	1					
Femur	2						1				1	
Patella	1											
Tibia	1		1	1								
Metatarsal	7		4	4	4	4	1				1	
1st phalanx	1	1	1	1	1	1	1					
2nd phalanx	5	3	4	4	4	4	4					
3rd phalanx	4	1	3	3	3	3	3					

Table 18 *Dicerorhinus* NISP, MNE and MNI values

Element	NISP	MNE	MNI
cranial	50	1	1
cheek tooth	3	1	1
tooth	11	1	1
rhino metacarpal III	1	1	1

Appendix 6 – Inter and Intra-Site Comparison

Table 1 NISP recorded in each weathering stage; numbers in parentheses are % of total NISP for each weathering stage.

	Weathering Stages					
Site	**0**	**1**	**2**	**3**	**4**	**5**
Boxgrove	455 (*27.5*)	601 (*36.4*)	414 (*25.1*)	144 (*8.7*)	38 (*2.3*)	0.0
Swanscombe	197 (*39.1*)	219 (*43.5*)	77 (*15.3*)	9 (*1.8*)	2 (*0.4*)	0.0
Hoxne	251 (*51.0*)	110 (*22.4*)	118 (*24.0*)	13 (*2.6*)	0.0	0.0
Lynford	329 (*9.4*)	786 (*22.5*)	598 (*17.1*)	1007 (*28.8*)	651 (*18.6*)	127 (*3.6*)

Table 2 NISP recorded in each weathering stage for red deer remains from fluvial deposits; numbers in parentheses are % of total NISP for each weathering stage.

	Weathering Stages					
Site	**0**	**1**	**2**	**3**	**4**	**5**
Cervus elaphus (Boxgrove)	5 (*17.2*)	10 (*34.5*)	12 (*41.4*)	2 (*6.9*)	0.0	0.0
Cervus elaphus (Swanscombe)	5 (*31.3*)	9 (*56.3*)	2 (*12.5*)	0.0	0.0	0.0
Cervus elaphus (Hoxne)	34 (*43.0*)	40 (*50.6*)	5 (*6.3*)	0.0	0.0	0.0

Table 3 NISP recorded in each weathering stage for faunal material from lacustrine deposits; numbers in parentheses are % of total NISP for each weathering stage.

	Weathering Stages					
Site	**0**	**1**	**2**	**3**	**4**	**5**
Boxgrove	99 (*21.2*)	180 (*38.5*)	142 (*30.3*)	40 (*8.5*)	7 (*1.5*)	0.0
Lynford	329 (*9.4*)	784 (*22.5*)	598 (*17.1*)	1007 (*28.9*)	645 (*18.5*)	127 (3.6)

Table 4 NISP recorded in each weathering stage for species from Boxgrove lacustrine deposits; numbers in parentheses are % of total NISP for each weathering stage.

	Weathering Stages					
Species	**0**	**1**	**2**	**3**	**4**	**5**
Stephanorhinus sp.	1 (*25.0*)	2 (*50.0*)	1 (*25.0*)			
Megaloceros sp.	3 (*50.0*)	2 (*33.3*)	1 (*16.7*)			
Equus ferus	25 (*18.5*)	47 (*34.8*)	56 (*41.5*)	6 (*4.4*)	1 (*0.7*)	0.0
Cervus elaphus	17 (*26.6*)	23 (*35.9*)	18 (*28.1*)	6 (*9.4*)	0.0	0.0
Capreolus capreolus	1 (*3.0*)	17 (*51.5*)	14 (*42.4*)	1 (*3.0*)	0.0	0.0
Deer/Horse sized	8 (*15.4*)	14 (*26.9*)	13 (*25.0*)	14 (*26.9*)	3 (*5.8*)	0.0
Large mammal	5 (*21.7*)	7 (*30.4*)	8 (*34.8*)	1 (*4.3*)	2 (*8.7*)	0.0
Indet	39 (*25.8*)	68 (*45.0*)	31 (*20.5*)	12 (*7.9*)	1 (*0.7*)	0.0

Table 5 NISP recorded in each weathering stage for faunal species from Lynford; figures in parentheses are % of total NISP for each weathering stage.

	Weathering Stages					
	0	**1**	**2**	**3**	**4**	**5**
Mammuthus primigenius	165 (*7.1*)	490 (*21.0*)	442 (*18.9*)	662 (*28.4*)	482 (*20.6*)	94 (*4.0*)
Coelodonta antiquitatis	13 (*28.3*)	29 (*63.0*)	0.0	3 (*6.5*)	1 (*2.2*)	0.0
Bison priscus	0.0	2 (*50.0*)	1 (*25.0*)	1 (*25.0*)	0.0	0.0
Equus ferus	0.0	1 (*14.3*)	4 (*57.1*)	2 (*28.6*)	0.0	0.0
Rangifer tarandus	16 (*15.5*)	33 (*32.0*)	21 (*20.4*)	8 (*7.8*)	19 (*18.4*)	6 (*5.9*)

Table 6 NISP recorded in each weathering stage for material from Boxgrove terrestrial deposits; figures in parentheses are % of total NISP for each weathering stage.

	Weathering Stages					
Site	**0**	**1**	**2**	**3**	**4**	**5**
Boxgrove	145 (*26.3*)	193 (*35.0*)	131 (*23.8*)	67 (*12.2*)	15 (*2.7*)	0.0

Table 7 NISP recorded in each weathering stage for major species from Boxgrove terrestrial deposits; figures in parentheses are % of total NISP for each weathering stage.

	Weathering Stages					
Species	**0**	**1**	**2**	**3**	**4**	**5**
Stephanorhinus sp.	2 (*10.0*)	3 (*15.0*)	12 (*60.0*)	2 (*10.0*)	1 (*5.0*)	0.0
Bison priscus	1 (*8.3*)	1 (*8.3*)	6 (*50.0*)	4 (*33.3*)	0.0	0.0
Equus ferus	0.0	0.0	1 (*16.7*)	3 (*50.0*)	2 (*33.3*)	0.0
Cervus elaphus	139 (*45.9*)	93 (*30.7*)	41 (*13.5*)	22 (*7.3*)	8 (*2.6*)	0.0
Capreolus capreolus	50 (*55.6*)	33 (*36.7*)	6 (*6.7*)	0.0	1 (*1.1*)	0.0

Table 8 Mood's median test comparing length of specimens from deer species at Boxgrove (B) and Lynford (L).

		N	Min	Q1	Median	Q3	Max
Length	B	241	0.95	3.21	5.83	9.605	40
Length	L	82	2.34	4.395	6.345	9.0375	66.5
	Median	**Chi-Squared**	**DF**	**Prob>Chi-Squared**			
Length	6.03	0.63925	1	0.42398			

Table 9 Mood's median test comparing length of specimens from deer species at Hoxne (H) and Swanscombe (S).

		N	Min	Q1	Median	Q3	Max
Length	H	36	2.5	4.31	6.595	11.465	28.2
Length	S	236	2	5.425	8	13	55
	Median	**Chi-Squared**	**DF**	**Prob>Chi-Squared**			
Length	8	2.81582	1	0.09334			

Table 10 Mood's median test comparing length of specimens from deer species at Boxgrove (B) and Hoxne (H) .

		N	Min	Q1	Median	Q3	Max
Length	B	241	0.95	3.21	5.83	9.605	40
Length	H	36	2.5	4.31	6.595	11.465	28.2
	Median	**Chi-Squared**	**DF**	**Prob>Chi-Squared**			
Length	6.03	1.19973	1	0.27338			

Table 11 Mood's median test comparing length of specimens from deer species at Boxgrove (B) and Swanscombe (S).

		N	**Min**	**Q1**	**Median**	**Q3**	**Max**
Length	B	241	0.95	3.21	5.83	9.605	40
Length	S	236	2	5.425	8	13	55
	Median	**Chi-Squared**	**DF**	**Prob>Chi-Squared**			
Length	7.2	16.60386	1	4.61E-05			

Table 12 Human and carnivore modification across large taxa expressed in relation to the total number of modified specimens (NISPMod); numbers in parentheses are percentages.

Site	**NISPHM**	**NISPPS**
Boxgrove	71 (*78.0*)	20 (*22.0*)
Swanscombe	1 (*20.0*)	3 (*60.0*)
Hoxne	12 (*92.3*)	1 (*7.7*)
Lynford	4 (*4.7*)	68 (*79.1*)

Table 13 Human and carnivore modification across medium taxa expressed in relation to the total number of modified specimens (NISPMod); numbers in parentheses are percentages.

Site	**HumNISP**	**PSNISP**
Boxgrove	100 (*88.5*)	11 (*9.7*)
Swanscombe	5 (*45.5*)	6 (*54.5*)
Hoxne	1 (*50.0*)	1 (*50.0*)
Lynford	6 (*31.6*)	13 (*68.4*)

Table 14 NISP modified specimens and distribution across taxa from Boxgrove fluvial deposits.

Species	**NISPMod**	**%NISPMod**
Stephanorhinus sp.	10	*7.4*
Bovidae sp indet	9	*6.6*
Equus ferus	1	*0.7*
Cervus elaphus	17	*12.5*
Dama dama	1	*0.7*
Capreolus capreolus	1	*0.7*
cervidae sp. Indet	42	*30.9*
Large mammal	53	*39.0*
Cattle/Horse size	1	*0.7*
Indet	1	*0.7*
Grand Total	136	100
Total NISPFluvial	196	
Total %modNISPfluvial		69.4%

Table 15 NISP modified specimens and distribution across taxa from Swanscombe fluvial deposits.

Species	**NISPMod**	**%NISPMod**
Palaeoloxodon antiquus	2	*12.5*
Megaloceros giganteus	1	*6.3*
Bos primigenius	1	*6.3*
Bovidae sp indet	1	*6.3*
Dama dama	11	*68.8*
Grand Total	16	100
Total NISPFluvial	504	
Total %modNISPfluvial		3

Table 16 NISP modified specimens and distribution across taxa from Hoxne fluvial deposits.

Species	NISPMod	%NISPMod
Megaloceros giganteus	1	*6.7*
Equus ferus	12	*80.0*
Cervus elaphus	2	*13.3*
Grand Total	15	100
Total NISPFluvial	403	
Total %modNISPfluvial		3.7

Table 17 NISP modified specimens and distribution across taxa from Boxgrove lacustrine deposits.

Species	NISPMod	%NISPMod
Stephanorhinus sp.	1	*0.8*
Megaloceros sp.	2	*1.7*
Equus ferus	54	*44.6*
Cervus elaphus	12	*9.9*
deer sized	16	*13.2*
large mammal	7	*5.8*
Indet	29	*24.0*
Grand Total	121	100
Total NISP lacustrine	468	
Total NISPmod% lacustrine		25.9

Table 18 NISP modified specimens and distribution across taxa from Boxgrove terrestrial deposits.

Species	NISPMod	%NISPMod
Stephanorhinus sp.	12	*17.4*
Megaloceros sp.	1	*1.4*
Cervus elaphus	35	*50.7*
cattle/horse sized	1	*1.4*
deer sized	3	*4.3*
large mammal	14	*20.3*
Indet	3	*4.3*
Grand Total	69	100
Total NISP terrestrial	764	
Total NISPmod% terrestrial		9.03

Table 19 NISP modified specimens and distribution across taxa from Lynford lacustrine deposits.

Species	NISPMod	%NISPMod
Mammuthus primigenius	78	*64.5*
Coelodonta antiquitatis	4	*3.3*
Bison priscus	1	*0.8*
Equus ferus	3	*2.5*
Rangifer tarandus	19	*15.7*
Deer/horse sized	1	*0.8*
Large mammal	6	*5.0*
Indet	9	*7.4*
Grand total	121	100
Total NISP lacustrine	3498	
Total %NISPmod lacustrine		3.5

Table 20 Comparison of mammoth remains from Lynford and La Cotte (layers 3 and 6).

Element	NISP Lynford	Lyn%	NISP La Cotte	LaCotte%
cranial	26	1.1	7	5.7
indet cranial frag	641	27.4	6	4.9
tusk	974	41.6	13	10.6
mandible w teeth	1	0.0		
mandible w/o teeth	12	0.5	2	1.6
maxilla w teeth	1	0.0		
maxilla w/o teeth	2	0.1		
upper molar	17	0.7		
lower molar	13	0.6		
lower tooth	1	0.0		
molar	94	4.0	17	13.8
stylohyoid	3	0.1		
atlas	1	0.0		
axis	1	0.0		
cervical vertebra			3	2.4
thoracic vertebra	10	0.4	2	1.6
lumbar vertebra	1	0.0	1	0.8
caudal vertebra	2	0.1		
vertebra	26	1.1		
rib	224	9.6		
sternum	3	0.1		
scapula	5	0.2	22	17.9
humerus	9	0.4	7	5.7
radius	1	0.0		
ulna	5	0.2	2	1.6
pelvis	9	0.4	29	23.6
femur	16	0.7	9	7.3
tibia	3	0.1	3	2.4
cuniform	2	0.1		
magnum	2	0.1		
2nd phalanx	1	0.0		
3rd phalanx	1	0.0		
indet long bone frag	175	7.5		
indet frag	58	2.5		
Grand Total	**2340**		**123**	

Figure 1 Length and width of faunal specimens from Boxgrove fluvial deposits; x-axis: length/width (cm), y-axis: frequency.

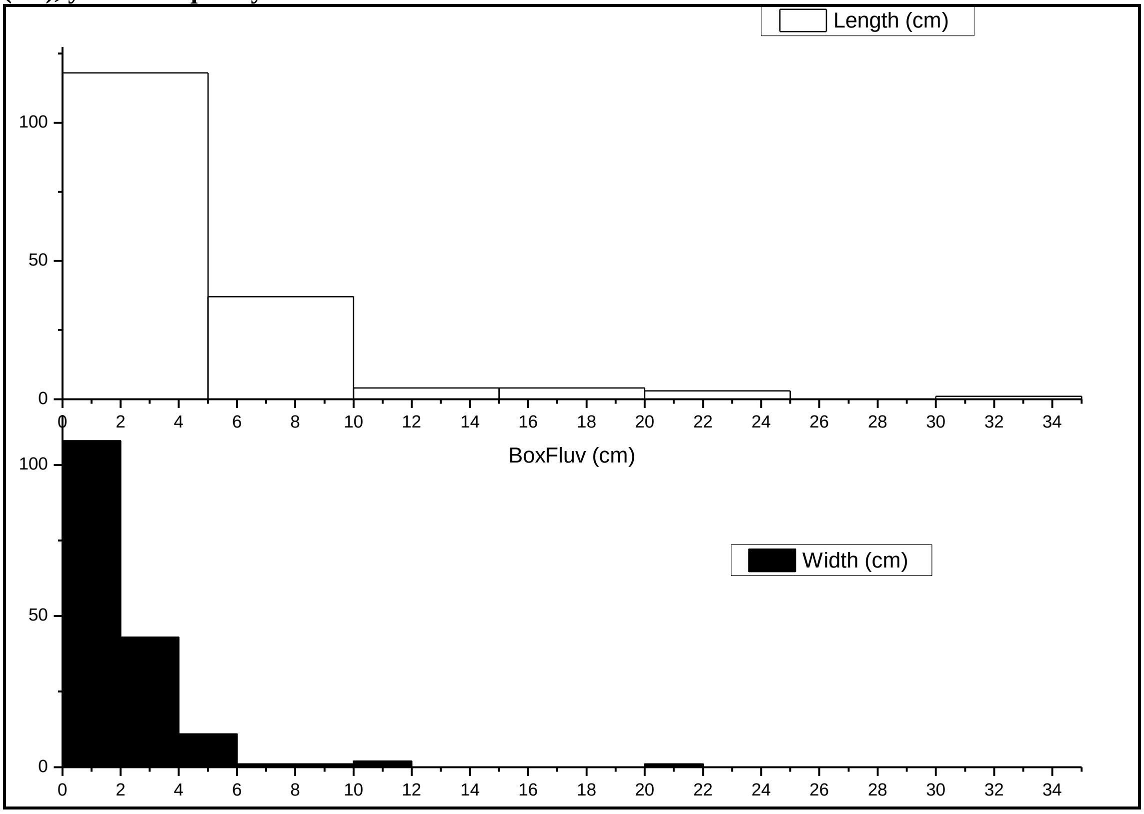


Figure 2 Length and width of faunal specimens from Swanscombe fluvial deposits; x-axis: length/width (cm), y-axis: frequency.